A STUDY OF FECAL FAT AND D-XYLOSE ABSORPTION TESTS IN SUSPECTED MALABSORPTIVE DISORDERS IN BUNDELKHAND REGION OF CENTRAL INDIA

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C E R T I F I C A T E

This is to certify that the work entitled "A STUDY OF FECAL FAT AND D-XYLOSE ABSORPTION TESTS IN SUSPECTED MALABSORPTIVE DISORDERS IN BUNDELKHAND REGION OF CENTRAL INdIA", which is being submitted as a thesis for M.D.(Medicine) Examination, 1993 of Bundelkhand University, has been carried out by Dr. Sanjay Kumar Johri, in the department of Medicine, M.L.B. Medical College, Jhansi.

He has put in the necessary stay in the department as per university regulations.

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The observations recorded were periodically checked and verified by me.

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(Sanjay Kumar Johri)

C O N T E N T S

I N T R O D U C T I O N

INTRODUCTION

Malabsorption disorders are a common cause of significant morbidity and mortality in developing countries like India. Often the cause is of an infective etiology like tropical sprue, giardiasis and intestinal tuberculosis. In other cases the cause could be disease of pancreas, gall bladder or even congestive cardiac failure. The presentation of malabsorption syndrome may vary enormously some patients may have classical features of bulky, foamy, greasy offensive loose stool, which float on water. These patients may have multiple vitamin deficiencies, in other patients, the presenting symptoms may be very non specific and protean. In such patients a high clinical suspician is required to reach the diagnosis.

Some important diseases causes malabsorption, include :

a. Pancreatic disease, including chronic pancreatitis, cystic fibrosis and Zolinger ellison syndrome.
b. Billiary tract diseases, include chronic cholicystitis, chronic lithiasis.
c. Small bowel diseases : Iliac tuberculosis, Crohn's disease, small bowel resection, trophic sprue celiac disease.
d. Blind loop syndrome.

In significant number of patients the cause of malabsorption is not evident even after extensive investigations.

The rational approach to a patient of suspected malabsorption include careful history of abdominal operations, thorough physical examination for detecting evident of vitamins minerals, deficiency and specific investigation. These investigation include routine blood test, haemoglobin, general blood picture, total serum cholesterol, serum proteins, small intestinal barium X-ray, jejunal biopsy and the quantitative test for fecal rat estimation in stool and D-xylose test. The last two test have been found quite sensitive for the malabsorption of fat and carbohydrate respectively.

A large number of patients attending our out patient department of our hospital suffer for symptoms suggestive of malabsorption. No systemic study on malabsorption now ever has been done so far in this region. We thus considered worthwhile to undertake evaluation of malabsorption parameters in this region.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Malabsorption is a comprehensive term which includes both defective hydrolysis of large molecules and ineffective uptake of breakdown products of these molecules in the small intestine.

Normal digestion and absorption can be divided into three sequential stages.

1. Intraluminal stages.
2. Intestinal stage.
3. Lymphatic transport stage.

PATHOPHYSIOLOGIC MECHANISMS

A pathophysiologic classification of different causes of impaired digestion and absorption and disease associated with these defects are summarised in table 1.

INTRALUMINAL STAGE

Impaired hydrolysis and solubilization of nutrients in the small intestinal lumen.

IMPAIRED FAT ABSORPTION

Because pancreatic lipase and colipase are necessary for triglyceride hydrolysis in the duodenum, dis-orders that cause pancreatic enzyme deficiency lead to fat malabsorption. Pancreatic enzymes are inactivated by a low luminal pH (as occur in the Zollinger Ellison syndrome) with consequent malabsorption of fat. The products of triglyceride hydrolysis namely fatty acid and

TABLE 1 : Pathophysiologic classification of malabsorption.

Affected mechanism	Pathophysiology	Associated diseases
I. INTRALUMINAL STAGE		
a. Digestion(fat, protein)	Decreased pancreatic enzyme and bicarbonate release Pancreatic enzyme inactivation by and rapid transit of nutrients, dilution of pancreatic enzymes.	Chronic pancreatitis, cystic fibrosis pancreatic carcinoma, Zollinger ellison syndrome, Post gastrectomy.
b. Solubilization (Fat)	Distruption of the enterohepatic circulation of bile.	Biliary tract obstruction, terminal ilial resection or disease small bowel bacteria over growth, cholestasiatic liver disease.
	Decreased CCK-PZ release	Extensive small intestinal obstruction.
c. Availability of ingested nutrients	Deficiency of intrinsic factor for promoting B_{12} absorption. Uptake of Vit. B12 by intestinal Bacteria tape worms. Binding by Oxalates of fatty acids or phytates.	Percicious anemia.
II. INTESTINAL STAGE		
a. Epithelial cell digestion(carbohydrate).	Disaccharidase deficiency	Lactase deficiency, Crohnns disease.
b. Epithelial cell transport (fat protein)	Loss of normal epithelial cells	Crohn's disease, celiac disease, Sarcoidosis tropical sprue, radiation enteritis, intestinal ischemia, whipple's disease, ilial resection, eosinophilic gastroenteritis colchicine, neomycin.
	Impaired amino acid transport, impaired Vit. B12 transport, impaired folate transport. Nonformation of chylomicrons Impaired transport of bile acid	Hartnup disease, cystinurie(Inherited vit. B12 deficiency, Congenital) folate deficiency. A betalipoproteinemia Primary bile acid malabsorption.
III. LYMPHATIC TRANSPORT STAGE (fat, proteins)	Lymphatic duct obstruction.	Lymphangiestasia, lymphoma, tuberculosis, carcinoid.
IV. UNEXPLAINED (MULTIPLE)		Diabetes mellitus, giardiasis, insufficiency hyperthyroidism Hypogammaglobulinemia.

monoglycerides are solubilized by bile salts to form micelles and are then absorbed in the small intestine. Disorder that interrupt the enterohepatic circulation of bile salts lead to impaired micelle formation and fat absorption.

IMPAIRED PROTEIN ABSORPTION

Although protein hydrolysis begin in the stomach through the action of pepsin, it mainly occurs in small intestine, catalised by pancreatic proteases. Deficiency of pancreatic proteases (trypsin, chymotrypsin and carboxypeptidase A and B) results in impaired hydrolysis of polypeptide. Therefore, chronic pancreatitis and pancreatic resection can lead to protein malnutrition. Pancreatitic proteases are also important for vitamin B_{12} absorption. These enzymes release vitamin B_{12} from R proteins, prior to binding with intrinsic factor. In profound pancreatic insufficiency, normal release of the vitamin from R proteins does not occur, so the amount of vitamin available for binding to intrinsic factor for absorption is decreased.

IMPAIRED CARBOHYDRATE ABSORPTION

Most diseases that cause carbohydrate malabsorption do so by affecting the intestinal stage of digestion and absorption. However, because pancreatic amylase catalyzes the hydrolysis of starch to oligosaccharides some carbohydrate malabsorption is seen in pancreatic insufficiency.

DECREASED AVAILABILITY OF INGESTED NUTRIENTS AND COFACTORS FOR ABSORPTION

Vitamin B_{12} malabsorption can result from intrinsic factor deficiency(following gastrectomy or antibody formation directed against gastric parietal cells or intrinsic factor in pernicious anaemia). A rare inherited disorder results in the production of an abnormal intrinsic factor by gastric parietal cells, which is unable to bind vitamin B_{12} in the intestinal lumen (Yand et al, 1985; Levine et al, 1985) and the absorption of vitamin is therefore impaired. In addition bacteria in the small intestine lumen of patients with blind loops syndrome can bind vitamin B_{12}. Vitamin B_{12} deficiency also occurs in patients infected with the fish tape worm, diphyllobothrium latum, because the worm completes with the host for dietary vitamin B_{12}.

Certain dietary constituents can bind nutrients in the intestinal lumen, which then become unavailable for absorption. For example, excessive dietary oxalate binds calcium with the consequent formation of calcium oxalate. Similarly, long chain fatty acids bind calcium (in fat malabsorption) and a high dietary phytate content binds iron.

INTESTINAL STAGE

Abnormalities of Small Intestinal Mucosa

Impaired Epithelial Cell Digestion :

Oligosaccharides are hydrolysed to monosaccharides by specific enzymes, located in the brush border membrane of intestinal epithelial cells and the monosaccharides are then transported across the cells. When specific brush border enzymes are deficient the non-absorbed oligosaccharide are metabolised by colonic bacteria to di and trisaccharides. Carbon dioxide and hydrogen with consequent abdominal distension and flatulence. Although a number of disaccharidase deficiencies have been described, the most common is lactase deficiency, which may be either congenital or acquired. Lactase is required for hydrolysis of lactose to glucose and galactose, which are then transported across the enterocyte by a sodium dependent active transport mechanism. Congenital lactose deficiency present in infancy and is rare. Aquired lactase deficiency may be either a primary decrease in the amount of the enzyme in the mucosa or may occur when there is abnormality or destruction of small intestinal cells as seen in celiac disease, acute infections enteritis, Crohn's disease tropical sprue or radiation enteritis.

IMPAIRED EPITHELIAL CELL TRANSPORT

Transport of Multiple Nutrients

A number of disease cause significant loss of intestinal surface area resulting in malabsorption of

all major dietary constituents. Conditions in which intestinal epithelial surface area is reduced or remaining epithelial cells are abnormal include celiac disease, tropical sprue, collagenous sprue, radiation enteritis, whipple's disease, eosinophilic gastroenteritis and intestinal ischemia. Extensive surgical resection of the small intestine also reduces the epithelial surface area available for absorption. Colchicine inhibits cell division and reduces the number of cells available for absorption and neomycin produces blunting of the small intestinal villi through an unknown mechanism leading to steatorrhoea. In all these disorders due to drugs steatorrhoea is typically mild (6 to 15 gm of fecal fat/day) and patients have decreased D-xylose absorption test.

TRANSPORT OF CARBOHYDRATE

Specific defects in the absorption of carbohydrate are usually caused by mucosal enzymes deficiencies. However, there is a rare, recessively inherited disorder in which carrier mediated transport of glucose and galactose in the intestinal epithelial cells membrane is impaired. This present clinically as a watery diarrhoea in infant shortly after births.

Transport of Amino Acids

There are also rare recessively inherited defects in amino acids transport. Hartnum disease is characterised by impaired transport of neutral amino acids (phenyl -

alaline and tryptophan) by intestinal and renal epithelial cells. Patients have pellagra like dermatitis due primarily to a deficiency of tryptophan (a precursor of nicotinamide). Although protein malnutrition is not seen because dipeptide absorption is normal. Similarly, patients with cystinuria although unable to transport dibasic amino acid (Cystine, lysine and arginine) have few symptoms of protein malabsorption. Patients with these disorders may have diarrhoea, attributed to bacterial metabolism of the excess amino acids in the intestine. They also have aminoaciduria with the formation of renal calculi in cystinuria.

TRANSPORT OF FATS

Micelles consisting of the product of triglycerides hydrolysis (monoglyceride, free fatty acids and glycerol) phospholipids, cholesterol and bile salts are transported from the intestinal lumen across the apical membrane of small intestinal epithelial cells. Disaggregation of micelles occurs during the transport process, diglycerides and triglycerides are resynthesized in the cells and subsequently chylomicrons are formed from triglycerides, phospholipids, cholesterol, and apoproteins. In the rare inherited disorders abetalipoproteinemia, chylomicrons formation is impaired due to absence of apolipoprotein B. Fat malabsorption results and fat accumulation within

epithelial cells because its export across the baso-lateral membrane is inhibited.

OTHER INHERITED TRANSPORT DEFECTS

Vitamin B_{12} deficiency is occasionally due to impaired intestinal transport. The vitamin B_{12} intrinsic factor complex can bind to ilial cells, but transacross the cells does not occur (Burman et al, 1985). In congenital folate deficiency folic acid transport is impaired as a result of a rare specific intestine cell transport defect.

LYMPHATIC TRANSPORT

Impaired transport of nutrients from the small intestine. Disease that cause lymphatic obstruction can lead to fat malabsorption and a protein losing entero-pathy. In intestinal lymphangiestasia, the subepithelial lymphatic are dilated and functionally obstructed. Consequently, removal of chylomicrons in the lymph is abnormally slow in this condition. In infiltrating disease of the small intestine (for example, tuberculosis enteritis, intestinal lymphoma, and whipple's disease). Mononuclease leucocytes may compress lymphatic vessels in the small intestinal wall and retard chylomicron removal. In addition, enlargement of regional lymphonodes (as in tuberculosis, lymphoma, metastastic carcinoma and metastatic carcinoid disease) may produce lymphatic obstruction and fat malabsorption.

UNCLEAR MECHANISM

A number of diseases are associated with malabsorption, but the pathophysiologic reason for the impaired absorption is unclear. Normal enterocyte function may be impaired in amyloidosis and giardiasis (Deka et al, 1982). A significant impairment of absorption of fat and D-xulose was seen in the rat with experimental giardiasis. Familial amyloidosis with polyneuropathy, steatorrhoea was found 58% and impaired D-xylose absorption in 52%. The main reason for the gasterointestinal dysfunction is a disruption of the gut autonomic nervous system rather than a barrier to absorption of nutrients across the intestinal wall (Steen and Ek, 1984). Malabsorption is common in patients with aquired immune deficiency syndrome (AIDS), some of whom have intestinal Kaposi's sarcoma or infection with mycobacterium avium intracellular, but in some no obvious etiology for diarrhoea and impaired absorption can be found (Scott et al, 1985, Allison and Bornman, 1983). Mild, but not severe, exocrine pancreatic insufficiency may occur in acquired immune deficiency syndrome however, fat malabsorption is more commonly associated with a small intestinal cause (Kapembwa et al, 1990). Kinetics of D-xylose absorption in patients with human immunodeficiency virus enteropathy, Ka (an absorptive rate constant) was reduced out of proportion to the minor histologic changes present in the duodenal biopsy specimens (Fli, D. Ehrenpreis et al, 1991).

Hypocholesterolemia has been noted to occur in the acquired immunodeficiency syndrome and has been associated with the malnutrition and cachexia often seen in end stage AIDS (Zumwalt, Schmidr, 1989; Falkanbach et al, 1989).

Inadequate diet and malabsorption have been frequently noted previously in AIDS patients (Gillin et al, 1985; Hickey, Weaves, 1988). Bacterial contamination of the small intestine is an important cause of occult malabsorption in the elderly (McEvoy et al, 1983).

Malabsorption of vitamin B_{12} and intrinsic factor secretion during Biguamide therapy 30% had malabsorption of vitamin B_{12} with drawal of the drug resulted in normal absorption in only half of those with malabsorption. The concept that biguamide can induce malabsorption by two different mechanism. One of these temporary and unrelated to intrinsic factor secretion and other is permanent and mediated by depression of intrinsic factor secretion (Adams et al, 1983).

Kinetic analysis of D-xylose absorption in normal subjects and in patients with chronic renal failure shows that nonrenal clearance of D-xylose is markedly reduced in chronic renal failure patients. D-xylose is less completely absorbed.in patients with chronic renal failure than in normal subjects. The absorption rate of D-xylose is slower in these patients than in normal subjects. The absorption rate is positively correlated with the extent of D-xylose absorption (Robert, 1983).

A case of a syndrome of malabsorption associated with Prurigo nodularis was reported. Her malabsorption syndrome was an idiopathic sprue, five months after treatment with gluten free diet supplement with vitamin and iron, the disappearance of the clinical and analytical alteration was compared (Suareg et al, 1984).

A study was done that is intestinal damage and malabsorption after treatment for cervical carcinoma malabsorption was found in 22% and 13% had vitamin B_{12} deficiency. Intestinal damage in tumour free patients occurred in 3% patients (Lantz and Einhorn, 1984).

A stiffman with malabsorption study was done, in which it was stated that pancreatitis has been found in patients of scleroderma (Greef, 1979; Davidson, [illegible], Epstein, 1983; Rai et al, 1986).

In a study duodenal pH in cystic fibrosis and its relation to fat absorption conclude was that a wide range of duodenal pH values found in patients with cystic fibrosis and that the efficiency with which enzyme supplements work is closely related to these pH levels (Pancreatic enzymes). Administration of misoprostal to those patients with (misoprostal, a known acid reducing agent) excessively acidic duodenal pH levels as well as residual malabsorption appears to be of benefit in improving both the excessively acidic pH levels and the fat malabsorption (Robinson et al, 1990).

Protein and fat absorption in prolong diarrhoea in infancy (Man et al, 1982).

In a study that fat absorption in premature infants the effect of lard (it was derived from pigs fed a diet high in polyunsaturated fatty acids in order to obtain a more "human milk like" fat profile) and antibiotic. It was suggested that no support for the use of lard in adopted cow's milk infant formulas to improve fat absorption (Verkade et al, 1989). A study lymphatic role in the pathogenesis of fat malabsorption in liver cirrhosis in rats. Data suggested that lymphostasis of the intestine may play an important role in fat malabsorption in liver cirrhosis (Soichiro Minra et al, 1982).

Another study impaired absorptive capacity for carbohydrate in the aging human it was suggested that subtle carbohydrate malabsorption should be consider when evaluating weight loss in old age and in fashioning nutrition programmes for the elderly (Joshva et al,1982).

In a study malabsorption associated with nonmalignant immunoprofliferative small intestinal diseases(IPSID) (O' Manonsos et al, 1987).

In another study malabsorption syndrome coccidiasis combine immune deficiency and fulminant lymphoproliferative disease. It was suggested a possible role of coccidial infection in malabsorption syndrome in immuno deficients patients. It also indicates the need for further study of the relationship between malignancy and metronidazole

in immunosuppressed patients(Aharan Hallak et al, 1982).

In a study, familial amyloidosis with polyneuropathy, aspect of the relationship between gastrointestinal symptoms, EMG finding, and malabsorption studied. The steatorrhoea was found in 58% and an impaired D-xylose absorption in 52%. It was suggested that the main reason for the gastrointestinal dysfunction is a disruption of the gut autnomic system rather than a barrier to the absorption of nutrients across the intestinal wall (Steen and Ek, 1984).

CLINICAL MANIFESTATIONS

HISTORY

Although many of the symptoms of malabsorption are non specific, for example, diarrhoea, weight loss, and symptoms of anaemia, clinical history can provide clue to the etiology of malabsorptions in some patients. Early symptoms of intestinal or pancreatic disease include fatigue bloating, anorexia, and passage of two to three loose stool per day. An increase in bulk may be the first change noticed by the patient. However, more advanced pancreatic insufficiency may be associated with classic symptoms of fat malabsorption, which include the passage of bulky, floating, malodorous stools. Although stools were considered to float because of a high fat content, they actually float becauseof increased gas (Levitt et al, 1972).

Some common clinical features of malabsorption and their pathophysiology are summarized in table 3.

Both small intestinal or pancreatic disease may result in profound weight loss. Although anorexia is more characteristic of small intestinal disease or pancreatic carcinoma than chronic pancreatitis.

TABLE 2 : Condition associated with impaired micelli formation.

Pathophysiology	Associated diseases
Decreased bile salt formation.	Severe parenchymal liver disease.
Decreased bile salt delivery to the duodenum.	Cholestatic liver disease (Primary biliary cirrhosis, drug induced cholestasis) bile duct obstruction (Cholengiocarcinoma, pancreatic carcinoma, gallstones, sclerosing cholangitis).
Decreased ionization of conjugated bile salts.	Zollinger - Ellison syndrome.
Decreased intraluminal bile salt concentration	Binding agents (Cholestyramine)
Bile salts deconjugation.	Bacterial over growth in jejunal diverticula, small intestinal fistula and strictures in Crohn's disease, scleroderma, intestinal pseudoobstruction, diabetes and elderly.
Increased intestinal bile salt loss.	Crohn's disease, small intestinal resection, cholecystocolonic fistula.

Patient with chronic pancreatitis tend to have hyperphagia, which may contribute to the marked fat excretion. Anaemia (due to vitamin B_{12}, iron, or folate malabsorption) may present with dyspnoea, dizziness, fatigue and pallor.

Diffuse abdominal pain is not usually associated with malabsorption unless extensive small intestinal disease with partial intestinal obstruction is present(as in Crohn's disease or radiation enteritis, for example). Patients with chronic intestinal ischemia classically have pain 20 to 60 minutes after meal and usually have other evidence of peripheral vascular disease. The abdominal pain of chronic pancreatitis tends to be epigastric with radiation into the back. Patient with small intestinal lymphoma frequently have severe periumbilical or generalized abdominal pain.

Recent foreign travel may be associated with parasitic diseases including giardiasis, and tropic sprue. Homosecual contact, intravenous drug abuse, or multiple blood transfusion predispose to infection with the human immunodeficiency virus (HIV). Patients [illegible] infected with this virus are prone to develop opportunistic infections caused by a variety of organisms including mycobacterium avium intracellular. Alcohol is toxic to the small intestinal mucosa affecting absorption(Green,1983) and chronic alcoholism abuse may cause pancreatic insufficiency and fat malabsorption. In a child small stature or failure to thrive are features of celiac disease and of cystic fibrosis. Malabsorption and concomitant bronchitis or bronchiectasis also suggest cystic fibrosis.

Patient with disaccharidase deficiencies experienc abdominal distension, nausea and water diarrhoea 30 to 90

TABLE 3 : Symptoms and signs of malabsorption.

Clinical features	Pathophysiology	Laboratory findings.
Diarrhoea	Increased secretion and decreased absorption of water and electrolytes : unabsorbed fatty acids and bile salts.	Increased fat excretion, decreased serum carotine, "Osmotic gap" in stool electrolytes
Weight loss with hyperphagia.	Decreased absorption of fat protein and carbohydrate.	Increased fat excretion.
Bulky fowl smelling stool.	Decreased fat absorption	Increased fat excretion
Muscle wasting oedema	Decreased protein absorption	Decreased serum albumin.
Flatulence borborygmi abdominal distension	Fermentation of carbohydrates by intestinal intestinal bacteria	Increased fat excretion Decreased D-xylose absorption.
Abdominal pain	Small intestinal stricture, infiltration of pancrease. intestinal ischaemia.	Increased fat excretion
Parasthesias tetany	Decreased vitamin D and calcium absorption	Hypocalcemia hypomagnesemia.
Bone pain	Decreased calcium absorption	Hypocalcemia, increased alkaline phosphatase.
Muscle cramps weakness	Excessive potassium loss.	Hypokalemia, abnormal ECG.
Easy bruisability	Decreased vitamin K absorption	Increased prothrombin time,
Hyperkerotosis night blindness.	Decreased vitamin A absorption	Increased fat excretion. Decreased carotene, increased fat excretion.
Pallor	Decreased vitamin B_{12}, folate or iron absorption	Macrocytic anaemia, microcytic anemia.
Glossitis, stomatitis Cheilosis.	Decreased vitamin B_{12}, folate or iron absorption.	Decreased vitamin B_{12} folate or iron.
Acrodermatitis	Zinc deficiency.	Decreased serum zinc.

minutes after ingesting a particular disaccharides sugar (milk sugar in lactose deficiency). Eosinophitic gastro-enteritis should be suspected in any patient with malabsor-ption and a history of food allergies. A history of peptic ulcer disease and diarrhoea raises the positivity of Zollinger Ellison syndrome. Abdominal surgery, particularly or Billroth II partial gastrectomy can lead to the creation of a blind loop of small intestine. It is also a cause of malabsorption, small intestinal resection may interrupt the enterohepatic circulation of bile salts with resulting fat malabsorption and if extensive may impair the absorption of other nutrients. In patients with malabsorptions, nondefor-ming arthritis neurologic symptoms or valvular heart disease, Whipple's disease should be considered. Scleroderma can lead to small intestinal dismotality and bacterial overgrowth Certain small intestinal diseases have dermatologic manifes-tations (for example, dermatitis herpatiformis in celiac disease). Some endocrine disorders (diabetes mellitus, addition's disease, hypoparathyroidism and thyrotoxicosis) are also associated with malabsorption.

Finally a careful drug history should be taken because certain drugs (for example, colchicine, cholesty-ramine, neomycin and cathartics) may cause malabsorption.

PHYSICAL EXAMINATION

If malabsorption is not severe, the physical examination may be normal or there may be minor physical

abnormalities including smooth lateral margins of the tongue and hyperactive bowel sounds. With more severe malabsorption, patients may show evidence of malnutrition, with muscle wasting particularly in the temporal areas, Pallor of mucous membranes suggests anaemia (which may result from malabsorption of iron, vitamin B_{12} or folate). Deficiencies of fat soluble vitamins can produce hyperkeratosis of the skin (Vit. A), ecchymosis and hematuria (Vit. K) and parasthesias, tetany, positive Chvostek and Trousseau signs and bone pain with vertebral collapse (Vit D and calcium). Patients with intestinal disease may have malabsorption of water soluble vitamins (Notably B vitamins) with resulting glossitis (riboflawn and niacin deficiency) and peripheral neuropathy (Vit B_{12} deficiency).

The prognosis of patients with malabsorption is determined by the nature of the underlying disease.

The clinical features and investigation of specific diseases will now be considered according to their pathophysiological classification.

INTRALUMINAL STAGE - DIGESTION

PANCREATIC DISEASE

Pancreatic proteases lipase and amylase are essential for normal digestion of nutrients and diseases of the pancreas typically produce significant fat malabsorption (commonly more than 25 gm of fecal fat excretion per day). Pancreatic bicarbonate secretion neutralizes gastric acid and maintains the duodenum at the alkaline pH

required for pancreatic enzyme activity. Profound destruction of the pancreas must occur before significant steatorrhoea results (Gastin et al, 1984; Dimagno, 1982).

Although chronic alcoholic pancreatitis is the commonest cause of pancreatic exocrine insufficiency, in one study 75% of patients with pancreatic carcinoma had fat malabsorption some of whom improved with exogenous pancreatic enzyme replacement(Perez, 1983). Symptoms of fat malabsorption predominate in patients with pancreatic exocrine insufficiency, but symptoms of impaired protein absorption (for example, muscle wasting and edema) also occur. Patients typically have hyperphagia and are able to maintain their weight despite significant malabsorption. Impaired vitamin B_{12} absorption is common but the B_{12} deficiency is rare. Symptoms result from malabsorption of the fat soluble vitamin(A,D,E and K) and from hypocalcemia caused by chelation of calcium by excess fatty acids in the institute.

Pancreatic disease should be suspected in any patients with steatorrhoea (determined by fecal fat excretion), normal small intestinal function(determined by D-xylose absorption) and without evidence of terminal ileal disease (determined by a small intestinal barium contrast radiograph). Pancreatic dysfunction may be confirmed by bentiromide test. The specific pancreatic disease(chronic pancreatitis, pancreatic resection or carcinoma) may be diagnosed by computerized tomography, endoscopic retrograde cholengio pancreatography, and if

necessary fine needle aspiration of the gland. If patients with known pancreatic disease fail to improve after pancreatic enzyme replacement, coexisting small intestinal disease should be sought (Lembe et al, 1985).

Pancreatogenous malabsorption in children is most commonly associated with cystic fibrosis. Rare syndrome as a sidroblastic anaemia (Pearson et al, 1979) or neutropenia (Schwachman syndrome (Gaskin et al, 1984) has been described.

ZOLLINGER - ELLISON SYNDROME

High gastric acid production stimulated by gastric secreting tumours of pancrease or duodenum results in impaired fat absorption. Excess acid in the duodenum had a dual effect on fat digestion by (a) inactivating pancreatic enzymes and (b) decreasing bile salt ionization. Acid suppression (by cemetidine or surgery) results in reversal of the malabsorption (King and Toskes, 1983; Kingham et al, 1981).

SURGERY FOR PEPTIC ULCER DISEASE

Malabsorption of fats and carbohydrates occurs after total or partial gastrectomy and is multifactorial in etiology. Gastric emptying rate is increased and gastric antral function is lost, resulting in inadequate grinding of food particle and inadequate mixing of nutrients with gastric secretion, as well as dilution of pancreatic enzymes

with decreased proteolysis and lipolysis(MacGregor et al, 1977).

Because the pancreas is innervated by the vagus, absolute levels of pancreatic enzymes are reduced after vagotomy and fat malabsorption results. Rapid gastric emptying after a partial gastrectomy or vagotomy and pyroroplasty causes a 10 to 50 percent reduction in glucose absorption(Radzink and Bondy, 1982). Following a Billroth II anastomosis bacterial overgrowth in the jejunal loop causes both bile salt and vitamin B_{12} malabsorption.

INTRALUMINAL STAGE : SOLUBILIZATION

DISRUPTION OF THE ENTEROHEPATIC CIRCULATION OF BILE

Bile salts are necessary for the effective solubilization of fats in the small intestinal lumen and any disease that interupts the normal enterohepatic circulation of bile can result in decreased micelle formation and fat malabsorption where low bile salt concentration in the duodenum are due to decreased production(severe parenchymal liver disease) decreased delivery(cholestatic liver disease, Biliary tract obstruction). Bile salt deconjugation to free bile acids (bacterial overgrowth), or increased bile salt loss (terminal ileal disease or resection). Symptoms relate to impaired absorption of fat and fat soluble vitamins. In these disorders protein and carbohydrate absorption remain normal. The absorption of vitamin B_{12} is impaired in bacterial overgrowth, as

intestinal bacteria compete with intrinsic factor for binding to vitamin B_{12} (Giannella et al, 1972) and in terminal ilial disease when receptors for the vitamin B_{12} intrinsic factor complex are lost.

Regardless of the cause patients with reduced bile salt concentration have significant steatorrhoea (15 to 20 gm excreted fat per day). The specific disorder resulting in decreased bile salts may be identified by routine liver function tests, small intestinal contrast radiographs and sonograph imaging of the biliary tract and pancreas. An abnormal ^{14}C D-xylose breath test is diagnostic of small intestinal bacterial overgrowth and an abnormal cholyl - ^{14}C-glycine breath test is suggestive of terminal ileal disease or resection or bacterial over growth. Finally cholecystokinin pancreozymes (CCK-PZ) a gut hormone secreted by I cells in the proximal small intestinal mucosa is essential for normal gallbladder contraction. Any disease that destroys the intestinal mucosa (for example, celiac disease) may reduce CCK-PZ release, reduce gallbladder contraction, reduce bile salt and pancreatic enzymes delivery to the duodenum and hence result in impaired fat absorption.

INTESTINAL STAGE : EPITHELIAL CELL DIGESTION

Disaccharide Deficiency

Aquired lactose deficiency is the most common disorder of carbohydrate absorption in humans. Lactose in

intestinal brush border epithelial cells is important for lactose hydrolysis in neonates but level decline after weaning (Kretschmer et al, 1981), so that by adulthood most humans are lactase deficient (Nuang and Bayless,1968). The rate of fall of lactase levels differs in different ethnic groups (Ravich and Bayless, 1983) and there is considerable variation in the prevalence of lactase deficiency among different races, occurring in more than 65% of people of Asian and African origin.

Symptoms of abdominal distension, flatulence and diarrhoea after ingestion of milk products commonly begin in adolescence. Diagnosis is best made by measurement of breath hydrogen after ingestion of lactose. Lactose levels in a small intestinal mucosal biopsy may be measured directly, although this rarely necessary clinically. (Hyams et al, 1980). As the symptoms of lactose intolerance are non specific and lactase deficiency is very prevalent diagnosis ultimately depends on the resolution of symptoms after elimination of milk from the diet. Lactose can be more readily absorbed from yogurt as intra-intestinal lactase is released by bacilli in Yogurt, facilitating digestion of lactose (Kolars et al, 1984).

Lactase deficiency also results from diseases that damage the small intestinal mucosa (celiac disease, tropical sprue, radiation enteritis) (Weiss and Styker, 1982) chronic alcoholics have reduced level of intestinal lactase which improve with abstinence (Perlow et al,1977).

Although lactose malabsorption was thought to influence the severity of symptoms in children with inflammatory bowel disease (Pena and Truclone, 1973 Sciaretta et al, 1984) a recent study of breath hydrogen elimination after lactose ingestion in 70 children with inflammatory bowel disease found to increased incidence of lactose intolerance (Kritschner et al, 1981). Milk intolerance may contribute to symptoms in patients with irritable bowel syndrome (Sciaretta et al, 1984).

Congenital lactase deficiency is a rare disorder in mucosal lactase levels are low at birth. Infants have watery diarrhoea, irritability and weight loss from the first feed of breast milk (Kirtschner et al, 1981) and improve on a lactose free diet.

Other rare inherited disorders of brush border enzymes include alpha dextrinase deficiency (Gray et al, 1976) and the lactose deficiency. In all these disorders the nonabsorbed carbohydrates are fermented by colonic bacteria to produce short chain fatty acids, CO_2 and hydrogen, which result in symptoms of abdominal distension flatulence and diarrhoea after ingestion of relevant sugar.

INTESTINAL STAGE - EPITHELIAL TRANSPORT

Many small intestinal diseases results in distruction of epithelial cells and loss of normal absorptive functions. Patients with celiac sprue (glutin sensitive

enteropathy) may have profound malnutrition secondary to mucosal distruction. Elimination of gluten from the diet usually reserves the small intestinal damage with improvement of enterocyte absorption. A variant of celiac disease has recently been described in six patients with loss of small intestinal villi, atrophy of the spleen and cavitation of mesentric lymph nodes (Matuchansky et al, 1984). All patients had abnormal D-xylose absorption, and four had steatorrhoea.

Small intestinal involvement in sarcoidosis is rare but can cause malabsorption with increased fecal fat excretion and abnormal D-xylose absorption (Sprague et al, 1984). Small intestinal biopsy reveals villous atrophy and multinucleate giant cells in the mucosa which resolves with steroid therapy. Other disorders causing loss of intestinal surface area for absorption are summarised in table 1(Crohn's disease, radiation enteritis, Whipple's disease, tropical sprue, eosinophilic gastroenteritis) specific defects in amino acid transport(Hartnum disease, cystinuria) and vitamin B_{12} and folate transport already discussed.

ALCOHOL

Acute and chronic alcohol ingestion directly damages the small intestinal mucosa with resulting altered absorption of nutrients.

Acute alcohol administration produces haemorrhagic erosion of the intestinal villous tips in alcoholic volunteers(Gottfried et al, 1976). Chronic alcohol ingestion in alcoholics produces ultrastructures changes in the mitochondria and endoplasmic retinaculum of the crypt and villous epithelial cells but no light microscopic changes to the intestinal mucosa (Rubin et al, 1972).

Steatorrhoea in alcoholic is primarily due to pancreatic insufficiency rather than mucosal disease. Alcohol administration in healthy volunteers causes impaired absorption of methionine, thiamine and D-xylose (Green, 1983) presumably due to intestinal epithelial cell damage. Small intestinal motility is also increased (Robles et al, 1974) and may contribute to the diarrhoea in alcoholics.

Small Intestinal Resection or Bypass

Resection of the small intestine is most commonly performed in patients with Crohn's disease with severe mucosal damage and stricture formation. Jejunoilial bypass was frequently used for the treatment of morbid obesity before the severe metabolic consequences were appreciated (Adibi and Stanko, 1984). Surgical resection of the small intestine decreased the surface area available for absorption. The affected nutrient and degree of malabsorption depend on a number of factors :

1. The extent and site of intestine resected.

2. The absorptive function of remaining small intestine. and the functional integrity of the liver and pancreas.
3. Adaptic responses of the remaining intestine and
4. The presence of the iliocecal value (Weser, 1976).

1. Patients who have had more than 75 percent of their small intestine resected have severe malabsorption with diarrhoea caused by the rapid transit of nutrients into the colon. If the jejunum alone is resected steatorrhoea is typically mild (approximately 10 gm of fecal fat per day) and the specific functions of the terminal ileum (Vitamin B_{12} and bile salt absorption) are maintained. However, after terminal ileal resection, the bile salt pool is reduced and micelle formation is inhibited, resulting in marked steatorrhoea (20-40 gm of fat daily). In addition, the unabsorbed fats and bile salts which reach the colon inhibit colonic water and electrolyte absorption and may stimulate colonic electrolyte secretion causing watery diarrhoea (Mckhian et al 1971; Ammon and Phillips, 1973). Bile salt induced diarrhoea occurs after as little as 100 cm of ileum is resected but steatorrhoea is usually mild (Hofmann and Poley, 1972).

2. Patients who have disease in the remaining small intestine have major difficulties in absorping nutrients (for example, Crohn's disease). Similarly patients with concommitant liver or pancreatic diseases may have reduced bile salt or pancreatic enzyme secretion

with aggravation of steatorrhoea. In patients who have a total colonic as well as ilial resection, water and electrolyte absorption in the colon is lost, and fluid losses in the ileostomy may become unmanageable.

3. There is good evidence from animal studies, that after resection of the jejunum adaptive changes occur in the remaining ileum. As early as one week after the resection, transit time is decreased (Curtis et al, 1984). The height of the intestinal villi and mucosal enzymes contents increase and intestinal absorption improves (McCarthy and Kim, 1973).

4. Nutrient malabsorption and diarrhoea seen to to less in patients who do not have resection of the ileocecal value. Intestinal transit time is prolonged and small intestinal contamination by colonic bacteria is reduced with preservation of the ileocecal value(Weser,1976).

Following intestinal resection or bypass patients may have impaired absorption of time elements (Calcium, magnesium, and vitamins, A, D, E and B_{12}). In normal individuals, oxalate in the diet is precipitated by calcium and little is absorbed. In patients with severe steatorrhoea, calcium binds to the excess fats and is unavailable for binding to oxalate, which remains soluble. Hence, oxalate absorption from the colon is increased, explaining the high incidence of oxalate renal stones in patients with terminal ileal disease.

For the management of patients with extensive small intestinal resection and an excellent review by Weser (1976). Although long term survival of patients with only 6-8 inches of remaining jejunum, in addition to duodenum is reported (Winawer and Zameneck, 1968). Life long intravenous hyperalimentation is usually necessary.

ABETALIPOPROTEINEMIA

A group of rare inherited defects in chylomicrons formation have been described. Following lipolysis fatty acids are passively transported into the enterocyte where chylomicrons are formed from phospholipids, cholesterol, triglycerides and apoproteins in the endoplasmic retinaculum prior to transport to the Golgi apparatus, children with abetalipoproteinemia or with homogygous. Hypobetalipoproteinemia are unable to synthesize chylomicrons (Isselbacher et al, 1974; Cottrill et al, 1974). The enterocytes become filled with fat and patients have fat malabsorption with steatorrhoea. A progressive sensory neuropathy, ataxia and retinitis pigmentosa are also characteristic of these diseases. Chylomicron retention disease is a redently described varient of abetalipoproteinemia with similar features of steatorrhoea and neurologic impairement (Roy et al, 1987). Both disease have an autosomal recessive made of inheritance and can be distinguished by the lipoprotein profiles in serum (Roy et al, 1987). Treatment consists of substituting medium chain triglycerides for dietary fat and supple-

menting with fat soluble vitamines, particularly vitamin E.

ADULT FAMILIAL HYLINE MEMBRANE DISEASE

A familial syndrome of progressive hyalinosis of capillaries, veins and arteries have recently been described (Ramband et al, 1986). Clinical manifestation include hypertension, retinal ischemia and subarachnoid hemorrhage.

ABNORMALITIES OF LYMPHATIC TRANSPORTS

Intestinal lymphoma should be considered in any patients with profound steatorrhoea and hypoalbuminemia. Lymphatic transport of chylomicrons and proteins is obstructed with consequent fat malabsorption and protein loss in to the intestine. In developed countries the disease is usually a localised ileal tumour, which may present with obstructive symptoms, where as in third world countries intestinal involvement is often diffuse and symptoms of malabsorption predominate (Mondhiry, 1986).

Other causes of obstruction of mesentric lymphatics include tuberculosis (Hanson, 1985), metastatic carcinoma, metastatic mesothelioma (Raptopoulos, 1985) and metastatic carcinoid (case records of the messachsetts general hospital, 1986, Seigel et al, 1980). Retractile mesenteritis and retroperitoneal fibrosis and disease of unknown etiology which cause lymphatic obstruction (case records of the Massachusetts General Hospital, 1984).

Lymphatic duct obstruction of any etiology is frequently associated with ascites. Primary intestinal lymphagiectasia is a genetically determined structure disorders of the lymphatics. Intestinal biopsy characteristically showes dilated lymphatics and the villi may also be distended or may appear normal.

Differentiation between these different causes of lymphatic obstruction may be difficult, lymph nodes in tuberculosis enteritis may be calcified, small intestinal biopsy may show malignant lymphocytes in primary lymphoma, and urinary 5-hydroxy indole acetic acid level are usually increased in metastatic carcinoid disease. But often definitive diagnosis is only made at laparotomy.

DISEASES OF UNEXPLAINED MECHANISMS

Enteropathy of the Acquired Immune Deficiency Syndrome (AIDS)

Diarrhoea and weight loss occur in approximately two thirds of male homosexual with the acquired immune deficiency syndrome (AIDS). Many of whom have malabsorption (Gillin et al, 1985; Koller et al, 1984). Although enteric pathogens may be present (Giardia, Cryptosporidium Isospora belli). In one recent study no identifiable pathogen could be identified by stool culture in 20/72 patients with AIDS and diarrhoea (Gillin et al, 1985). D-xylose absorption was impaired in all patients, fat malabsorption was common. Intestinal biopsy revealed mycobacterium avium intra-

cellular in 5 of the 20 patients and specific inflammation without pathogens in 13 of 20. Jejunal biopsy in some patients revealed partial villous atrophy, but the causative agent was not identified. Thus, these seems to be an enteropathy associated with AIDS which present with diarrhoea and symptoms of malabsorption but without an identifiable etiology.

Even when organisms are seen on intestinal biopsy, the pathophysiologic mechanism of the malabsorption in these patients is unexplained. Infection with cryptosporidium in immunocompetent hosts causes an acute self limited diarrhoea. However, in AIDS patients cryptosporidium produces a severe incapacitating diarrhoea with major fluid and electrolyte loss and occasionally nutrient malabsorption. (Rodgers and Kagniff, 1987). Isospora belli may be identified by acid fast stains of stool specimens or by electron microscopy of a small intestinal biopsy (Schun and Gelb, 1984). Light microscopy of the small intestine typically reveals partial villous atrophy. Microsporidia have been found in the intestinal mucosa of patients with AIDS and diarrhoea but malabsorption has not been associated with the organisms and their importance in the pathogenesis of diarrhoea is unclear (Rodgers and Kagnoff, 1987).

Myobacterium avium intracellulare is an important pathogen in patients with AIDS and is known to produce PAS positive inclusions in intestinal macrophages, similar to

the lesions identified in whipple's disease (Strom and Gruninger, 1983). Although malabsorption is commonly associated with this pathogen the pathophysiologic mechanism is not known (Gillin et al, 1985).

Cytomyalovirus infection in AIDS patients typically cause diarrhoea and occasionally colonic perforation. Although small intestinal involvement has been described, diffuse colonic ulceration is seen more commonly (Rodgers and Kagnoff, 1987) and malabsorption has not been reported. AIDS patients with gastrointestinal kaposi sarcoma are usually asymptomatic (Friedman et al, 1985).

ENDOCRINOPATHIES

A number of endocrine disorders are associated with malabsorption. Abnormalities of gastrointestinal motility have been documented in patients with thyroid disease, and rapid intestinal transit may cause the impaired fat absorption which is frequently associated with thyrotoxicosis (Shofer et al, 1984; Thomas et al, 1973). Similarly the steatorrhoea observed in patients with addison's disease improved with steroid replacement Mild steatorrhoea is also reported in patients with deficient parathyroid function, in whom diagnosis may be made by measuring parathormone levels. Treatment with vitamin D and calcium will improve the steatorrhoea as well as other symptoms of the disease. Patients with long standing diabetes mellitus frequently have diarrhoea and

may have mild steatorrhoea (Wruble and Kalser, 1964). Although a few patients have associated pancreatic exocrine insufficiency and some have intestinal bacterial overgrowth, in most diabetes small intestinal histologic findings and pancreatic exocrine function are normal autonomic neuropathy is common in these patients and dysmotility may predispose to bacterial overgrowth but small intestinal culture rarely reveal increased organisms and steatorrhoea rarely improves with antimicrobial therapy.

MALABSORPTION IN THE ELDERLY

Poor intake is probably the major cause of malnutrition. But in a recent study 45% of elderly patients were found to have bacterial over growth of the small intestine (McEvay et al, 1983). Impaired absorption of fat(Webster et al,1977) and carbohydrate(Feibusch and Halol, 1982) has been reported in patients over 65 years of age, although mechanism is unclear. Investigations of these patients may reveal unsuspected anatomic abnormalities (for example jejunal diverticular).

OTHER DISORDERS

Both primary and secondary amyloidosis may involve the small intestine and cause malabsorption. proposed mechanism include small intestinal ischemia from amyloid infiltration of mesenteric arterioles, amyloid deposition in the lamina propria inhibiting transport of

nutrients and altered intestinal motility. Of note as only 50 percent of the patients with intestinal amyloidosis have impaired D-xylose absorption, damage to the small intestine seems to be variable (Steen and Ek, 1984). Giardiasis is known to cause steatorrhoea, but the mechanism is unclear. However, there is evidence that giardiasis lamlia trophozoits can take up bile salts and may thus reduce intraluminal bile salt concentration, leading to fat malabsorption (Farthing et al, 1985).

DRUG INDUCED MALABSORPTION

Colchicine, a drug commonly used in the treatment of gout, inhibiting epithelial crypts cells division (Race et al, 1970). Mild steatorrhoea and impaired D-xylose absorption may result. Neomycin produce partial villous atrophy and impaired D-xylose and fat absorption in doses as low as 4 gm per day. The pathophysiologic mechanism is unclear although lipolysis of fats is reduced and bile salts in the intestinal lumen may be precipitated by the drugs (Rodgers et al, 1966). Bacitracin polymyxin and kanamycin any cause malabsorption. Clindamyxin in therapeutic doses inhibits jejunal water and electrolyte absorption, which may in the absence of pseudomembranous colitis, Contribute to diarrhoea that occur during Clindomycin therapy (Spiller et al, 1984). Methotrexate (Gwavava et al, 1981) an irritant laxatives appear to impair absorption by directly damaging small intestinal epithelial cells. Cholestyramine in the doses of 12 gms

or more per day, binds bile salts in the intestinal lumen and impaire fat absorption. The oral anticoagulant phenindione also cause steatorrhoea by an unknown mechanism Aluminium containing antacids bind dietary phosphate and can lead to hypophosphatemia hyper calciuria and nephrolithiasis.

CLINICAL TESTS OF DIGESTION AND ABSORPTION

Numerous tests are available for evaluating patients with symptoms of maldigestion and malabsorption. A logical approach to investigating such patients can be made if attention is given to clinical features suggestive of specific etiologies during a careful history and physical examination(for example excess alcohol intake causing shall intestinal or pancreatic disease). Routine laboratory tests may also be helpful. Thus, a macrocytic or microcytic anaemia would suggest deficiency of vitamin in B_{12}, folate or iron, respectively and hypoalbuminemia might indicate protein malabsorption or a protein lossing enteropathy. A low serum carotene level would suggest impaired fat absorption, which would then be investigated directly by a quantitative sudan stain and then measurement of quantitative fecal fat.

In patients with chronic pancreatitis, a plain abdominal X-ray may demonstrate pancreatic calcification (this is present in 30 percent such patients)(Rober et al, 1978) whereas an abdominal CT scan may demonstrate a pancreatic mass in patients with pancreatic carcinoma.

If fat malabsorption is due to small intestinal disease, carbohydrate absorption as determined by D-xylose absorption a hydrogen broth test or a bile acid breath test is likely to be abnormal.

Small intestinal barium X-ray may show evidence of previous intestinal surgery(subtotal gastrectomy or massive small bowel resection) or may show partial intestinal abstruction in a patient with Crohn's disease or lymphoma. Distortion of the second portion of the duodenum by pancreatic carcinoma may also be seen on barium contrast radiographs. A small intestinal biopsy may provide diaghostic information in patients with specific mucosal diseases and occasionally may be used to measure disaccharidase activities in patients with suspected disaccharidase deficiencies.

A schematative approach to investigating the patient with suspected malabsorption is summaried in figure-1. The range of normal values for the different test is given in table 4. Some of the more frequently used tests will now be considered in further detail.

TABLE 4 : Tests for malabsorption in common clinical use.

Tests	Test reflects	Normal values	Abnormal results indicate	Factors affecting interpretation of the test.
Serum carotene		⩾0.06 mg/dl	Pancreatic insufficiency, small intestinal disease.	Inadequate dietary fat
Qualitative fecal fat	Fat digestion and absorption	a few fat globules per high power/field		Incomplete collection
Quantitative fecal fat		⩽6 gm/day		Inadequate dietary fat.
Schilling test	Vitamin B_{12} absorption	⩾7%/24 hours	Pernicious anaemia primary vit. B_{12} malabsorption.	Renal insufficiency
D-xylose (25 gm orally)	Carbohydrate absorption	⩾4gm/5 hr(urine) ⩾20gm% at 2 hour in serum	Small intestinal mucosal dysfunction bacterial overgrowth	Renal insufficiency, age, ascites
Lactose tolerance test	Lactase activity of enterocytes	⩾20 mg/dl rise in blood.	Acquired lactase deficiency, congenital lactase deficiency, Crohn's disease, radiation enteritis, celiac sprue.	
Bentiromide test(PABA).	Pancreatic secretion	⩾57% arylamine excretion/6 hrs.	Pancreatic insufficiency extensive small intestinal wall damage.	Renal or liver disease, diabetes
Breath tests				
a. ^{14}C-xylose	Carbohydrate digestion and absorption	⩽0.001% of administered dose at 30 min.	Bacterial overgrowth	Delayed gastric emptying
b. Cholyl ^{14}C-	Enterohepatic circulation of bile acids.	⩽1% of administered dose any time within 4 hours.	Bacterial overgrowth, terminal ileal disease/ resection.	
c. Lactase H_2	Lactase activity of enterocytes	⩽20 ppm rise in breath H_2 anytime within 3 hours.	Lactase deficiency.	
Small intes- culture	Bacteria in the small intestine	⩽10^5 organism/ml	Bacterial over growth	Unrepresentative sampling of the small intestine inadequate culture techniques.
Small intestinal biopsy.	Small intestinal morphology			Unrepresentative sampling of the small intestine.

SELECTION OF TESTS IN THE EVALUATION OF MALABSORPTION

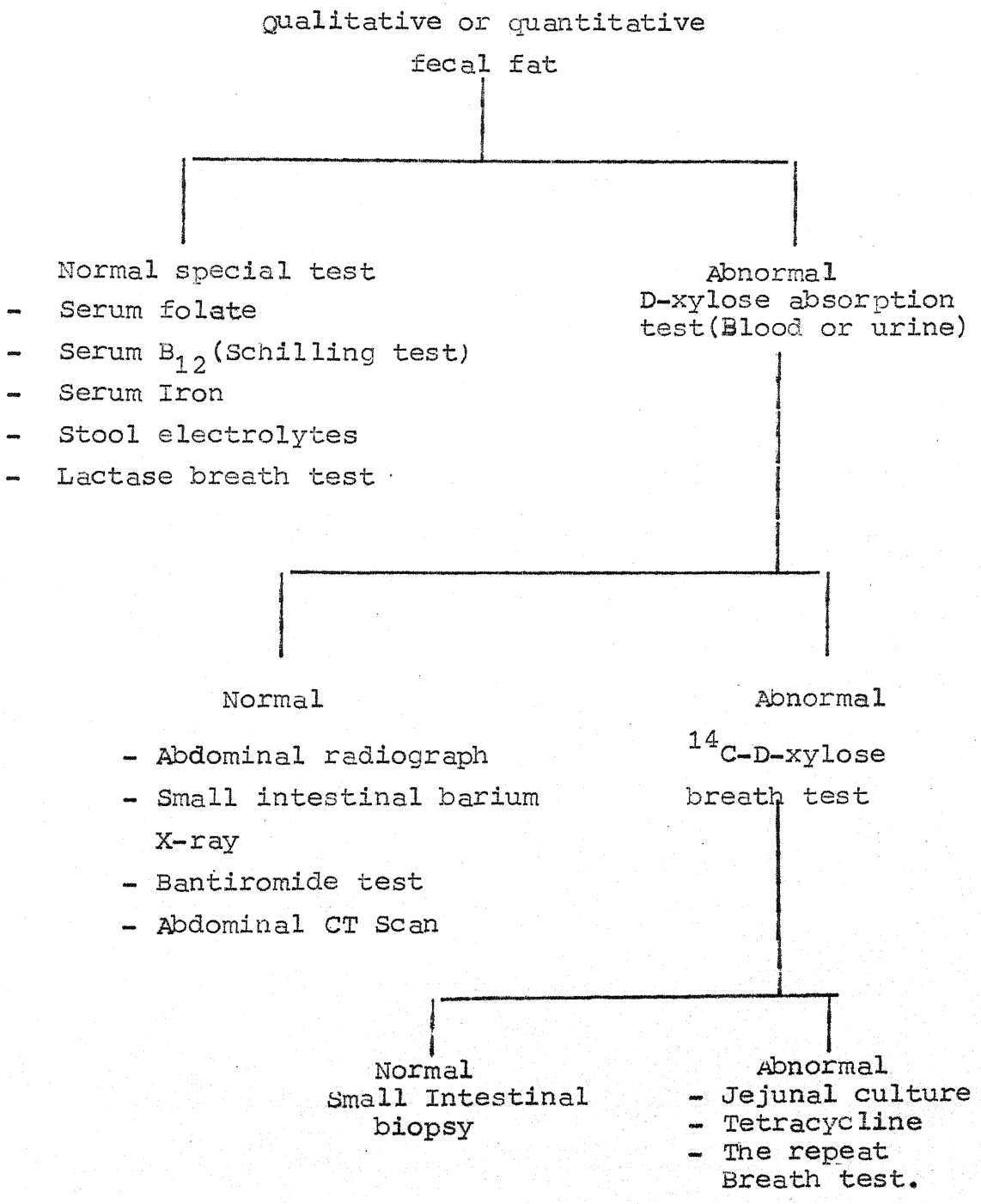


Figure 1.

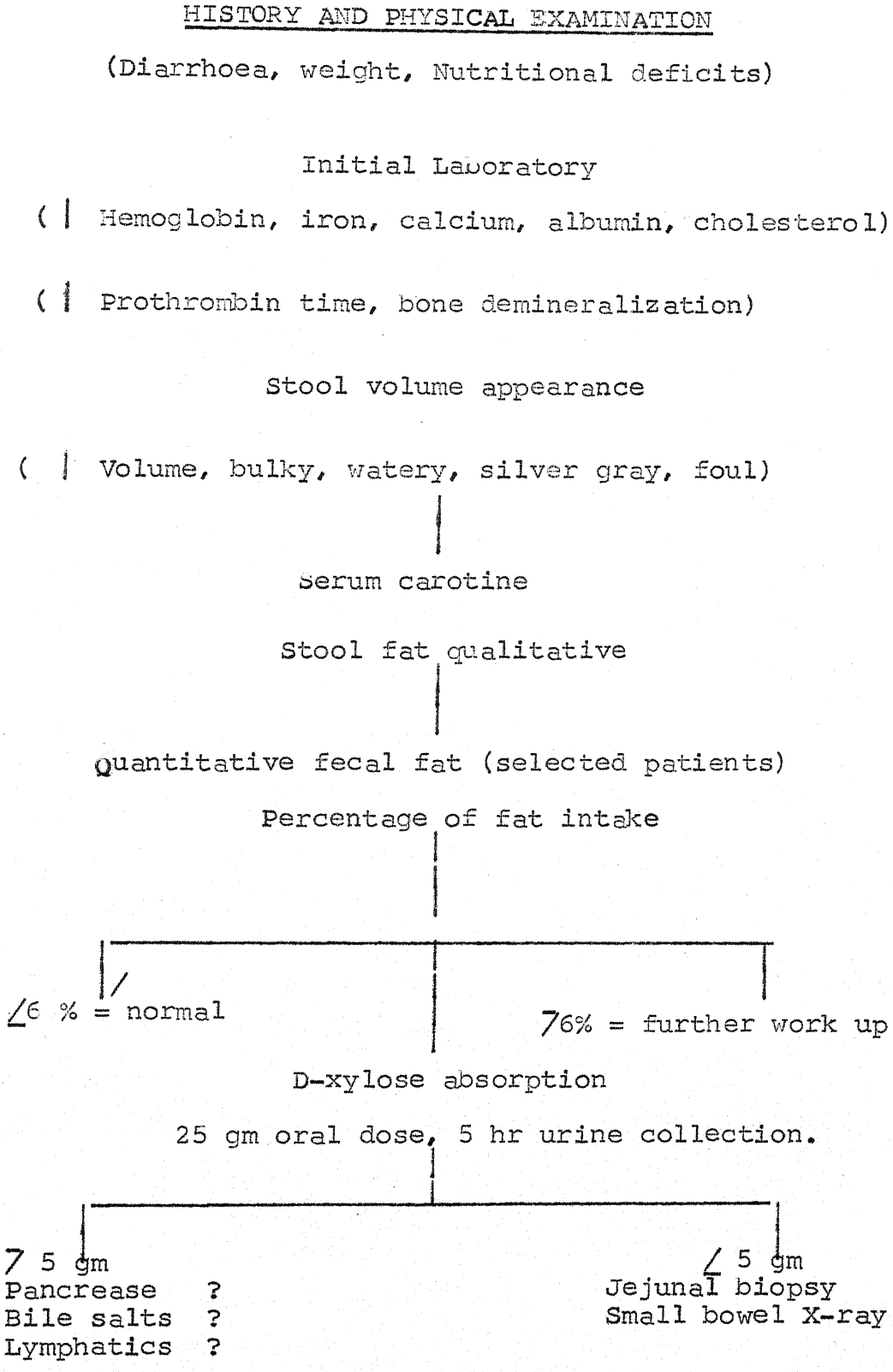


Fig. 2 : Format for malabsorption work up by Roger and Gebhard (1983).

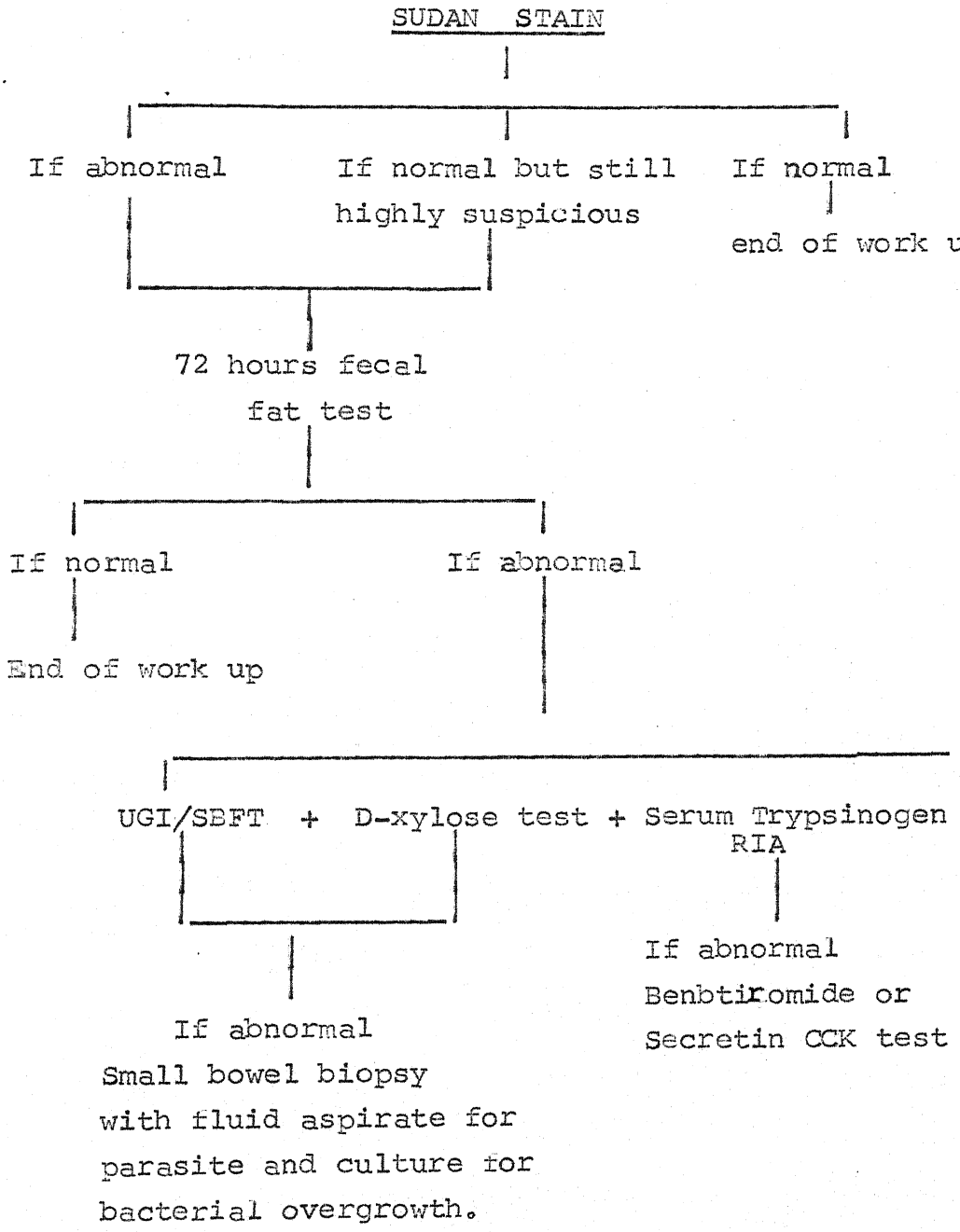


Fig. 3 : Decision tree for suspected malabsorption UGI/SBFT upper gastro intestinal series and small bowel follow through RIA - Radio-immunoassay CCK cholecystokinin (By Igram M Roberts, 1987).

TESTS OF FAT ABSORPTION

Qualitative fecal fat

This simple test is useful for screening individuals with suspected fat malabsorption and correlated well with the quantitative fecal fat (Doummey et al,1961; Ghosh et al, 1977). The qualitative fecal fat test is most useful in patients with moderate to severe fat malabsorption (excreating more than 10 percent of a daily intake of 60 gm of fat) in whom it is positive in 94 to 100 percent of cases. In patients with mild to moderate fat malabsorption (Excreting 6 to 10 percent of dietary fat), the test is less sensitive and will be positive in only 75 percent of cases. In addition, 14 percent of fecal specimens from healthy individuals (excreting ⁄7 percent of dietary fat) will have a slight increase in microscopic estimate of fecal fat (Drummey et al, 1961). The test is perrormed on a stool specimen which is placed on a glass slide and mixed with two drops of glacial acetic acid and two drops of Sudan III in 95 percent alcohol.

In moderate steatorrhoea many fat globules the size of erythrocytes are present, and in severe steatorrhoea many fat globules greater in size than erythrocytes are seen. In patients with a positive test the degree of fat malabsorption should be further evaluated with a quantitative fecal fat measurement. Patients ingesting minerals, oils may have a false positive test.

False negative qualitative fecal fat tests arise in patients with inadequate dietary fat intake or mild steatorrhoea.

QUANTITATIVE FECAL TEST

Measurement of the amount of fat in the stool excreted in three days by a patient on a daily diet containing 80-100 gm of fat is the best method for evaluating fat malabsorption. The stool specimen is analysed by the Van de Kamer method (Van de Kamer et al 1949), which is based on extraction and titration of long chain fatty acid by NaOH. Fecal fat levels greater than 6 gm per day are abnormal and suggest undully small intestinal, pancreatic or hepatobiliary disease. If the patient is on a 100 gm per day fat diet and a complete three day stool specimen is collected, the test provides a useful measure of the amount of fat which is not absorbed by the small intestine and it remains the "Gold standard" to which all other tests of fat absorption were compared. Small errors arise in patients taking medium chain triglycerides (Braddock et al, 1968) or mineral oils (Drammey et al, 1961) which interefere with fecal fat analysis. It must be remembered that fecal fat level may be normal in patients with advanced destruction of the pancreas since pancreatogenous steatorrhoea will not usually appear until the enzyme output of the gland has been reduced to /2 percent of normal values(Gaskin et al, 1983).

Recent attempts have been made to introduce less cumbersome tests of fat absorption which avoid the problem of inadequate dietary fat intake and inadequate collection of excreted fat. The most widely used of such test is the "C-triolein breath test". A new double-isotope method using radiolabelled triglycerides and free fatty acids, as well as a nonabsorbable marker to assess the adequacy of the fecal collection promises to overcome some of the deficiencies of the quantitative fecal fat test but requires further evaluation (Thorsgard Pedersen and Halgreen, 1985).

^{14}C-TRIOLEIN BREATH TEST

Triolein is a triglyceride (glyceryl trioleate) that normally is hydrolyzed by pancreatic lipase in the small intestine and after absorption and further metabolism contributes to the CO_2 in exhaled air. Following oral administration of glyceryl tri (1-^{14}C) oleate, exhaled $^{14}CO_2$ is trapped by hyamine, then quantitated by scintillation counting. In patients with impaired fat absorption the amount of $^{14}CO_2$ exhaled in six hours after an oral dose of ^{14}C-labelled triolein is reduced. This test has been validated in patiens with steatorrhoea (Newcomer et al, 1979; Butler et al, 1984). It is easier to perform than the 72 hours fecal fat test but as with other tests of fat absorption, provides little information about the

cause of malabsorption in any particular patient. In addition result may be misleading in patients with altered metabolism of absorbed ^{14}C-triolein or impaired excretion of $^{14}CO_2$ in breath (for example in patients with diabetes, obesity, thyroid disease, pulmonary disease and liver disease, a condition which are often associated with chronic pancreatitis) it is also insensitive in detecting early pancreatic insufficiency and is a qualitative rather than a quantitative test. A variant of this test employs triolein labelled with the non-radioactive isotope ^{13}C, which is quantitated by mass spectrometry.

In an attempt to differentiate patients with pancreatic and small intestinal disease, Goff has repeated the test after pancreatic enzyme replacement(The two stage triolein breath test) and found an increase in $^{14}CO_2$ excretion in patient with pancreatic insufficiency (Goff, 1982). At present the triolein breath test is a available only in research laboratories.

SPECIFIC PANCREATIVE FUNCTION TEST

Radiographic techniques (ultrasounds Computerised tomography and cholangiopancreatography) have greatly improved our ability to diagnose chronic pancreatitis, but tests of pancreatic function are helpful in establi shing whether structural abnormalities of pancreas are the cause of the patients symptoms. Pancreatic function tests measure the ability of pancreatic acinar cells to

secrete enzymes and bicarbohate into the duodenum following certain stimuli. However, most of these tests are insensitive in detecting pancreatic insufficiency, as they are only abnormal when enzyme secretion is reduced to less than 10 percent of normal level (Di Mango et al, 1973).

BENTIROMIDE TEST

The underlying principle of this noninvasive test of pancreatic function is that an adequate duodenal concentration of chymotrypsin is necessary to cleaye free paraaminobenzoic acid (PABA) from the synthetic peptide N-benzoyl-L tyrosylparaaminobenzoic acid(Bentiramide) (Toskas, 1983; Weizman et al, 1985).

After a 500 mg oral dose of bentiromide free PABA is released in the duodenum absorbed conjugated in the liver and excreted in the urine, where it is measured in 6 hour urine sample. PABA excretion is reduced in severe pancreatic insufficiency when enzyme output is less than 5 percent of normal. In addition, patients with defective intestinal absorption, renal disease, diabetes or severe liver disease may have diminishedurinary PABA excretion in the absence of pancreatic insufficiency (Di Magno,1982; Neideran and Grendell, 1985). Modification of the test involving measurement of plasma PABA levels have increased its accuracy (Weizman et al, 1985).

PANCREATIC STIMULATION TESTS

In these tests the duodenum is intubated and the duodenal contents are aspirated after a specific stimulus (Intravenous secretin or cholecystokinin or a liquid meal containing fat, protein and carbohydrate, known as the lundh meal). Duodenal fluid is analysed for pancreatic enzymes (lipase, colipase trypsin or chymotrypsin) and bicarbonate content. Although these test remain the "Gold standard" by which other pancreatic tests are measured they are cumbersome to perform and are uncomfortable for the patients and are rarely used clinically.

SCHILLING TEST

Approximately 50 percent of patients with pancreatic exocine insufficiency have impaired absorption of vitamin B_{12}, as measured by the standing Schilling test (Brugge et al, 1980). The standard schilling test measures vitamin B_{12} absorption and is used to detect the intrinsic factor (IF) deficiency in patients with pernicious anaemia. The test is also abnormal in patients with genetic defect in vitamin B_{12} absorption, bacterial overgrowth of small intestinal extensive mucosal destruction resection or bypass of terminal ileum and pancreatine insufficiency(for which the dual label schilling test was developed).

In the standard schilling test an oral dose of vitamin B_{12} (0.5 to 2.0 ug radiolabelled with either ^{57}CO or ^{58}CO) is given with a simultaneous intramuscular injection of 1 mg of nonradioactive vitamin B_{12} (which saturate hepatic binding sites for vitamin B_{12} and reduces the amount of radio-active vitamin B_{12} retained by the liver). The urine is collected for 24 hours following the administration of vitamin B_{12} and the amount or radio-activity determined. Patients with normal absorption and normal renal function excreate more than 7 percent of the radioactive vitamin B_{12} in 24 hours and those with impaired of collection. The low level of urinary radiolabelled vitamin B_{12} in patients with pernicious anaemia is corrected when the test is repeated and 60 mg of intrinsic factors is given orally with the test dose of labelled vitamin B_{12} (second stage schilling test). Patients with small intestinal bacterial overgrowth often show malabsorption of vitamin B_{12} with the first stage schilling test because of bacterial utilization of the vitamin which however is not corrected in the second stage test by administration of intrinsic factor. In such patients the absorption of vitamin B_{12} plus intrinsic factor remain low, but usually a week of antibiotic treatment for example, metronidazole, 250 mg three times/day) eliminates the intestinal bacteria and restores the vitamin B_{12} absorption of the first stage test to normal.

The dual label schilling test was developed to provide information about pancreatic exocrine function because proteases are required for the release of vitamin B_{12} from so called - R-proteins of gastric juice which preferentially bind the vitamin (Allen et al, 1978). For vitamin B_{12} to become bound to intrinsic factor the action of proteases in the duodenum is essential. The vitamin B_{12} thus released will then be bound to intrinsic factor in the duodenum. This test compares the absorption of ^{58}CO labelled vitamin B_{12} given orally bound to R-protein and ^{57}CO labelled vitamin B_{12} is given orally bound to intrinsic factor. In pancreatic insufficiency, the ^{58}CO labelled vitamin B_{12} is malabsorbed and the ratio of ^{58}CO : ^{57}CO in a urine specimen is lower than if pancreatic function is normal (Brugge et al, 1980). In patient with bacterial overgrowth of the small intestine or distal ileal disease both forms of vitamin B12 are malabsorbed, but the ratio of the cobalt isotops in the urine is normal. The dual label schilling test is no longer in clinical use because attempts to standarized this test by different laboratories have not been successful. Normalization of vitamin B_{12} absorption after pancreatic enzyme replacement as measured by the standard schilling test suggests pancreatogenous malabsorption.

TESTS OF CARBOHYDRATE ABSORPTION

HYDROGEN BREATH TEST :

In normal individual, hydrogen in produced

exclusively by the bacterial metabolism of carbohydrates. This test measures the hydrogen exhaled at times intervals during the first three hours after ingestion of carbohydrate under investigation (for example, lactose, lactulose, fructose or sucrose) (Levitt, 1969; Perman et al, 1984). Patients who are unable to digest or absorb carbohydrates in the small intestine have increased delivery of carbohydrates to the colon and hence increased production of hydrogen, which is then absorbed in the colon and exhaled by lungs. Patients with small intestinal bacterial overgrowth have increased hydrogen production by the ingested bacteria. The peak excretion is early i.e. within 3 hours. Patients with small intestinal disease and carbohydrate malabsorption have a later peak of hydrogen release as do patients with disaccharidase deficiency who have ingested the appropriate disaccharide.

The hydrogen breath test is now the most commonly used test to diagnose lactose deficiency (Newcomer et al, 1975) and is more sensitive than the lactose tolerance test. After measurement of basal breath hydrogen levels. An oral dose of lactose (1 gm per kg of body weight) is given A rise of $\bar{7}$20 ppm in exhaled hydrogen is diagnostic of lactose malabsorption. Patients with bacterial overgrowth of small intestinal bacteria in response to ingested carbohydrate (50 or 80 gm of glucose or 10 gm of lactulose) and an early peak of hydrogen exhalation after carbohydrate ingestion. The hydrogen breath test appear to be comple-

mentary to other breath test in diagnosing small intestinal bacterial overgrowth (Metz et al, 1976). A controlled diet on the day before the test affects fasting breath hydrogen levels and may improve the accuracy of this test (Perman et al, 1984; Kerlin et al, 1984). Because it is simple to perform and does not involve radioisotopes. This test is commonly used to study carbohydrate absorption in children. Of note, patients with severe pancreative insufficiency may have impaired carbohydrate absorption and positive hydrogen breath test (Kerlin et al, 1984).

D-XYLOSE ABSORPTION TEST

Xylose is a five carbon sugar that is incompletely absorbed in the small intestine by the same transport mecnanism as glucose and galactose. Intestinal uptake of xylose occurs by both passive diffusion and active transport, but unlike glucose and gluctose, xylose is not completely metabolised after it is absorbed but it largely excreted innchanged in the urine. The xylose absorption test has been used extensively to assess the functional integrity of the small intestinal mucosa. After an overnight fast a 25 gm (less commonly, 5 gm) dose of D-xylose a given orally and the patient is encouraged to drink fluids to maintain a good urinary output. Approximately 25 per cent of the administered dose is excreted in the urine (Normal values in a five hour urinary collection after a 25 gm oral doses, 7̄5 gm). In patients with fat malabsorp-

tion this test is useful to differentiate between small intestinal disease (in which xylose absorption is diminished and pancreatic insufficiency (in which xylose absorption is normal) however, xylose absorption may be normal in patients with only mild impairment of small intestinal mucosal function and in patients with predominantly distal small intestinal disease (Ryan and Olsen, 1983). The accuracy of the test is increased by measuring serum D-xylose levels one or two hours after the oral dose (normal levels more than 20 mg/dl two hour after a 25 gm dose or 11 to 22 mg/dl one hour after a 5 gm dose(Finley et al, 1964; Sladen and Kumar, 1973; Kaeney et al, 1978).

After an oral dose, serum D-xylose level should be normal in patients with impaired renal function(elderly individuals or patients with renal parenchymal disease in whom urinary xylose level will be diminished) and in patient with ascites (in whom xylose is retained in the ascitic fluid). Serum D-xylose levels will also be decreased in more than 85 percent of patients with bacterial over growth of the small intestine as bacterial metabolism of xylose in the intestinal lumen decreased the amount available for absorption (Haeney et al, 1978). In patients with bacterial overgrowth and small intestinal mucosal function D-xylose absorption any urinary excretion are likely to increase after oral administration of antibiotics.

In summary, the D-xylose absorption test is useful for evaluating patients with steatorrhoea. If serum and urinary levels are reduced, the patient should be further investigated with a jejunal biopsy or test for bacterial overgrowth. If D-xylose absorption is normal steatorrhoea is likely to be due to pancreatic insufficiency.

LACTOSE TOLERANCE TEST

This test is performed to identiry patients with either a specific defect in lactose absorption (congenital or acquired lactase deficiency) or a more generalised defect in carbohydrate absorption (for example, mucosal abnormalities associated with Crohn's disease). After oral administration of 50 gm of lactose, plasma glucose is measured at one and two hour. In normal subjects, the plasma glucose rises by more than 20 mg/dl whereas little increase in plasma glucose level is seen in most patients. with lactase deficiency. The lactose tolerance test may not defect certain patients with biopsy proved lactase deficiency(6 to 25 patients in one study)(New Comer et al, 1975) and has largely been replaced by the more sensitive breath hydrogen test.

ILEAL INTUBATION TESTS

Intubation tests have been recently described which directly quantify the unabsorbed carbohydrate reaching the ileocecal value (Stephen et al, 1983; Higachi et al, 1986).

These tests are easier to interpret than the D-xylose absorption or hydrogen breath tests as carbohydrate fermented by colonic bacteria is not measured by the tests. Intubation tests provides promise in the investigition of carbohydrate absorption, but further validation and comparison with the other tests are necessary.

TESTS FOR BACTERIAL OVERGROWTH

QUANTITATIVE BACTERIAL CULTURE

To quantify bacteria in the small intestine, the jejunum is intubated either with a peroral small intestinal tube passed under fluoroscopy or with a tube passed through an endoscope and the intestinal aspirate culture for both aerobic and anaerobic bacteria. In normal individuals, $<10^3$ bacteria per mililiter (usually streptococci and staphylococci) are cultured. The presence of $\geq 10^5$ bacteria per mililiter (commonly coliforms and anaerobes) has been used as the minimum concentration for diagnosis of small intestinal overgrowth. However, this test requires special culture techniques to detects anaerobic bacteria and is not as useful for diagnosing bacterial overgrowth as the breath tests.

Breath Tests

Bacteria in the small intestine metabolized only administered carbohydrate bile salts with the release of CO_2 in exhaled air. This is the underlying principle of

the ^{14}C-D-xylose and chalyl-^{14}C-glycine tests. Both these tests are in clinical use.

^{14}C-D-xylose Breath test

This clinical breath test measures $^{14}CO_2$ in exhaled air following oral administration of 1 gm of ^{14}C labelled D-xylose. In patients with small intestinal bacterial overgrowth , gram negative aerobic bacteria metabolize ^{14}C-D-xylose to $^{14}CO_2$ which following absorption is exhaled. Eighty five percent of these patients will have a diagnostic elevation of exhaled $^{14}CO_2$ within 60 minutes of ingesting ^{14}C-D-xylose (King and Toskes, 1983). In patients with delayed gastric emptying and small intestinal bacterial overgrowth (for example, in scleroderma), the release of $^{14}CO_2$ may be delayed until three hours confirmation of bacterial overgrowth is obtained by the normalization of this test and resolution of the malabsorption after antibiotic administration. The labelled xylose breath test has been shown to be more reliable than quantitative bacterial culture for diagnosing bacterial overgrowth because multiple test of xylose absorption give reproducible results in 95 percent of patients compared to only 38 percent for bacterial culture (Tillman et al, 1981). In addition because xylose is absorbed in the proximal small intestine, little is available for metabolism by

colonic bacteria and $^{14}CO_2$ release is not increased in patients with small intestinal resection.

CHOLYL-^{14}C-GLYCINE BREATH TEST

The bile and breath test is based on the normal enterohepatic circulation of bile salts. In contrast to the normal situation following the oral administration of cholyl ^{14}C-glycine anaerobic bacteria in the small intestine of patients with the bacterial overgrowth deconjugate the bile salt with the release of glycine. The glycine is then absorbed and after further metabolism, $^{14}CO_2$ is released, resulting in an early peak of radioactivity in the expired air. Unfortunately this test cannot easily differentiate between bacterial overgrowth and small intestinal disease or resection , in which unabsorbed cholyl glycine is metabolised by colonic bacteria with a delayed release of $^{14}CO_2$. Comparisons of the radiolabelled cholyl glycine and D-xylose breath test in the patients with culture proved bacterial overgrowth have shown that the latter test more accurately identifies patients with blind loop syndrome (King et al, 1980; Schneider et al, 1985).

TESTS OF BILE SALT ABSORPTION

The cholyl ^{14}C glycine breath test may also be used to identify patients with impaired ileal absorption of bile salt (King and Toskes, 1983) although it cannot

reliably differentiate patient with bile salt deconjugation due to small intestinal bacterial overgrowth from patients with bile salt malabsorption secondary to small intestinal disease or resection. The measurement of fecal ^{14}C may increase the accuracy of the cholyl glycine breath test, but it also decrease the facility with which those test is performed (Rutgeerts et al, 1979). The recently developed 75 Se MCAT test overcomes some of these difficulties and attempts to measure the total bile salt balance in patients.

75 Se HCAT TEST

This radioactive taurocholic acid analogue (23-Selena-25-Homotaurocholic acid) undergoes a similar interohepatic circulation to taurocholic acid and has recently been used to detect patients with increased bile acid loss. After oral administration of the compound the patient is screened under a gamma camera on sequential days and the amount of retained bile acid is quantitated, patient who retain less than 34 percent of the administered dose after three days are considered abnormal(Sciaretta et al, 1986). This test has been used to identify patients with bile acid malabsorption secondary to vagatomy or ileal resection many of whom have improvement in their diarrhoea. When treated with cholestyramine (Sciarette et al, 1986; Merrick et al, 1985). In these small studies 20 to 50 percent of patients with idiopathic diarrhoea had decreased

retention of 75 Se HCAT suggesting bile acid malabsorption and 75-100 percent of these patients had syptomatic improvement when taking cholestyramine. Although the 75 Se HCAT test is not in general clinical use. It is simple to perform and promise to be helpful for identifying patients who have idiopathic bile acid malabsorption (Popovic et al, 1987) who may respond to cholestyramine therapy.

RADIOGRAPH OF THE SMALL INTESTINE

The primary role of barium contrast radiograph of the small intestine is to define anatomic abnormalities which may be associated with bacterial overgrowth. A true blind loop, small intestinal stricture (as in patients with Crohn's disease or those who have undergone abdominal surgery), multiple jejunal diverticula or marked small intestinal hypomotility (as in scleroderma) all cause stasis which leads to bacterial colonization and overgrowth with serious impairment of digestion and absorption. Pancreatic carcinoma or pseudocyst in patients with chronic pancreatitis may be detected by distortion of the sweep of the descending duodenum. Radiograph are less important in the diagnosis of infiltrative diseases of the small intestine. In patients with celiac sprue barium X-ray typically show intestinal dilatation with little mucous thickening.

TABLE 5 : Histologic features of small intestinal diseases causing malabsorption.

Diseases	Histologic features	Pattern of distribution
Celiac sprue	Villous flattening, crypt, hyperplasia, increased lymphocytes and plasma cells in lamina propria.	Diffuse in proximal jejunum
Tropical sprue	Shortened villi, increased lymphocytes and plasma cells in lamina propria.	Diffuse in proximal jejunum
Crohn's disease	Noncaseating granuloma with or without giant cells	Patching lesions particularly affecting terminal ileum.
Collagenous sprue	Subepithelial collagen deposits	Diffuse
Primary lymphoma	Malignant lymphocytes or histiocytes in lamina propria variable villous flattening.	Patchy
Whipple's diasese	Lamina propria laden with PAS staining, foamy macrophages bacilli in macrophages.	Diffuse
Amyloidosis	Amyloid deposition in blood vessels muscles layer.	Diffuse in muscularis mucosa mucosal sparing.
Abetalipoproteinemia	Lipid laden vacuolated epithelial cells,normal villi	Diffuse.
Radiation enteritis.	Flattened villi mucosal inflammation fibrosis,ulceration	Patchy
Lymphangiectasia	Dilated lymphatic in lamina propria	Patchy
Eosinophilic gastroenteritis.	Eosinophilc infiltrate in the intestinal wall	Patchy
Hypogammaglobulinemia	Villous flattening giardia trophozoites often present few plasma cells.	Patchy
Giardiasis	Trophozoites maybe present, variable villous flattening.	Patchy
Opportunistic infections	Organism maybe seen(isospora belli, cryptosporidia, microsporidia) PAS staining macrophages (Mycobacterium avium intracellular).	Patchy

MUCOSAL BIOPSY OF THE SMALL INTESTINE

Mucosal biopsy is essential for the diagnosis of many diseases of the intestinal mucosa. Characteristics histologic changes in different diseases are summarised in table 5.

Finally if a specific diasaccharidase deficiency is suspected an unfixed intestinal biopsy can be analyzed for diasaccharidase activity (Dahlquist, 1968) Decreased disaccharidase levels may be secondary to small intestinal disease or may represent a primary disaccharidase deficiency.

AIMS AND OBJECTIVES OF STUDY

1. To study the spectrum of malabsorptive disorders in Bundelkhand region of Central India.

2. To evaluate the role of faecal fat estimation and D-xylose absorption test in those patients suspected of having malabsorptive disorder.

3. To establish the control values of faecal fat excretion and D-xylose absorption test in normal healthy volunteers of Bundelkhand region, India.

MATERIAL AND METHODS

MATERIAL AND METHODS

The study was conducted on patients attending the medical out patient department and admitted to the wards of M.L.B. Medical College,Hospital, Jhansi during the period from Feb., 1991 to April, 1992. Those patients who had symptoms of malabsorption syndrome included in this study. Their prior written consent was taken. All these patients remained admitted in the hospital during the whole period of study.

All the patients were subjected to detailed interrogation about their diseases and specific symptoms suggestive of malabsorption. A thorough physical examination was done to look for signs of deficiency of vitamins and minerals and protein energy malnutrition. The following criteria were employed for selection of the subjects for this study.

1. History of diarrhoea for 3 months or longer and loss of weight.
2. One or more of the following features :
   a. Anaemia
   b. Glossitis
   c. Stomatitis.
   d. Pigmentation of skin.
   e. Odema of dependent parts of body
   f. Emaciation or cachexia.

The subjects investigated in this series fulfilling the above criteria were broadly put in

two groups :

1. Patients of chronic diarrhoea with no detectable primary cause.
2. Patients of chronic diarrhoea with a known etiology other than protozoal or helminthic infestation.

Total number of 58 patients were studied. Patients under the age of 12 years were not included in the study because they attended the Pediatric Medicine out patient department of the hospital and complete follow up was not feasible.

Twenty control subjects were studied. They were patients convalescing from relatively minor medical illness. None of the control subject had any known history of gastrointestinal disease.

INVESTIGATIONAL PROCEDURE

1. A detail clinical history and physical examination.
2. Naked eye and microscopic examination of stool.
3. Routine haematological examination : Hb%, TLC, DLC, ESR etc.
4. For anaemic RBC count (Red blood cells count), PCV, (Packed cells volume), MCHC (Mean corpuscular haemoglobin), MCV (Mean corpuscular volume), MCHC (Mean cospuscular haemoglbin concentration), peripheral blood picture, bone marrow examination.
5. Total serum proteins (albumin and globulin).

6. Serum cholesterol.

7. Urine albumin, sugar, and microscopic examination.

8. Stool for ova and cysts, trophozoits.

9. Fecal fat excretion test.

The quantitative determination of fat in timed stool collection.

10. D-xylose test - with 25 gms dose.

Depending upon the requirement suggested by history and physical examination, selected patients were also be subjected to barium meal follow through examination sigmoidoscopy, Montoux test, chest X-ray, upper gastrointestinal endoscopy and other relevant investigations.

Based on the results of the faecal fat estimation, D-xylose test and other relevant tests the diagnosis of malabsorption syndrome was considered or excluded. Efforts were also made to find out the cause of malabsorption in individual cases.

METHODS

1. Determination of total fat contents of feces.

Indications :

Exocrine pancreatic deficiency, tropical sprue, coiliac disease, blind loop syndrome, short bowel syndrome, lymphoma, amyloidosis, tuberculosis, Crohn's disease, idiopathic protein loosing entropathy, Whipple's disease, abeta-lipoproteinaemia.

Patient's Preparation

Patient was given 75 gms of fat (butter) for 6 days, 72 hours stool for the last 3 days was collected. The fat content of the stool sample was estimated by the method of Van de Kumar (1949) and expressed as grams of fat excreted per 24 hours. Stool fat excretion of more than 5 gm/24 hours signifies fat malasborption.

Fallacies

In accuracy of proper times stool collection is the major fallacy. In patients whose bowel movements are infrequent, it may be necessary to use marker, but we did not enemate or marker used for collection of stool.

ESTIMATION OF FECAL FAT (VAN DE KAMER et al, 1949).

This is a convenient and rapid method and is particularly suited for use in connection with fat balance test. Results are expressed in terms of fatty acids.

Principles

Feces are saponified with concentrated KOH in ethanol and the fatty acids are liberated with HCl. The fatty acids are extracted with alcohol and petroleum ether and determined by titration of an aliquot of the petroleum ether extract with alkali.

Reagents

Ethanol 96% containing 0.4% amyl alcohol. Ethanol 96% neutral to thymol blue, Potassium hydroxide 33%. Hydrochloric acid 25%, specific gravity petroleum ether boil point 40-60° or 60-80° when evaporated to dryness this must leave no residue which can be titrated or saponified with alkali NaOH, 0.1 N thymol blue 2% in 5% ethanol.

Caution

The entire procedure should be carried out in a hood smoking and naked flames should not be permitted.

Procedure

1. Give the patient 75 gm butter fat daily for six days.
2. Collect the stool for the last three days (72 hours) for estimation.
3. Weight about 5 gm of faces in a 150 ml elhenmeyer flask.
4. Add 10 ml of 33% potassium hydroxide and 40 ml of ethanol containing 0.4% amyl alcohol and mix well.
5. Boil the mixture for 20-30 minutes under a reflux condenser.
6. After boiling add 17 ml HCl (25%) and again cool and mixture.
7. Add 50 ml of petroleum ether.

8. Close the flask with a rubber stopper and shake flask vigorously for one minute (20 times making).
9. Allow petroleum ether to separate.
10. Transfer the 25 ml contents into a small elhenmeyer flask and a small pieces of filter paper is added to prevent irregular boiling.
11. Evaporate the petroleum ether to dryness at 90^{o} a stream bath.
12. Add 10 ml of neutral ethanol and mix well.
13. Titrate the fatty acids with sodium hydroxide (0.1 N) using thymol blue as an indicator.

Calculations

An average molecular weight 284 is assessed for fatty acids, hence :

$$\frac{A \times 284 \times 1.04 \times 2 \ G}{10,000 \times Q} = \frac{5.907 \times A \times G}{100 \times Q}$$

where, A = ml of 0.1 N NaOH required for titration.

Q = feces taken for analysis (in gm).

G = gm feces per 24 hours.

The factor 1.04 is used because the petroleum ether layer increase 1% in volume when shaken with the HCl reagent and because 3% of the fatty acids remain in the acid alcohol layer.

D-XYLOSE ABSORPTION TEST

This test was done to assess the integrity of jejunum to absorb carbohydrates

Reagents

1. P-Bromoaniline reagent, 2% solution (2 gm/100 ml).
2. Saturated solution of thiourea in glacial acetic acid prepared fresh and stored the reagent in dark glass bottle (maximum a week).
3. Zinc sulphate 5%.
4. Barium hydroxide (0.3 N)
5. Stock standard solution : Dissolved 200 mg of xylose in 100 ml of saturated benzoic acid.
6. Working standard is prepared by dilution the stock solution to 1 to 10 and 1 to 20 with saturated benzoic acid. These contain 0.2 and 0.1 mg xylose per mililitre respectively.

Patient's preparation

The patient was fasted over night and empties his urinary bladder before the test. He was preferably resting in bed. The test was done by giving 25 gms of D-xylose in 250 ml of water orally. He was given a glass of water every hour to ensure a good urinary volume. The total urine can be collected in the next 5 hours and can be assessed for D-xylose. Normal 5 hours excretion is more than 4.2 gms. Five hour urinary

excretion less than 4 gms after a 25 gms is indicative of D-xylose malabsorption. The test can be done with 5 gm D-xylose, when 5 hours urinary excretion is less than 1.0 gm is consider abnormal.

We estimated D-xylose in blood. After two hours of giving D-xylose to patient blood sample collected with potassium oxylate(Pinch) then it is estimated by calorimeter.

Method

1. The test was done after fasting over night.
2. Patient was allowed to empty the bladder completely.
3. He was given an oral dose of 25 gms D-xylose in 250 ml water.
4. He was not allowed to take any thing during the study.
5. He was given 250 ml water to drink after one hour.
6. Blood sample was collected after 2 hours.
7. Xylose content can be determined in urine. But we determined in blood by colorimetric estimation.

COLORIMETRIC ESTIMATION OF D-XYLOSE

Principle

Xylose was determined by the formation of furfural and its reaction with parapromoaniline acetate to form a pink colour product at 70°C and in presence of the antioxidant thiourea. The estimation has a high

degree of specificity.

Procedure for Blood

1. De-proteinize 1 volume of blood sample after adding of volume of water and 1 volume of zinc sulphate (5%) and BaOH (0.3 N).
2. Filter and proceed as described above using 1 ml filtrate.
3. Used standard containing 0.1 mg xylose per ml.

Barium Meal Study

Small intestine was carried out with micropaque the non-flocculable barium sulphate 4 ounces of barium sulphate, suspended in an equivalent quantity of water was given to the over night fasting patient. Roentgenographic observations were made at intervals usually half an hour. A 6 hours film was taken routinely in all the patients. In few patients film at 9 hours were also taken.

O B S E R V A T I O N S

OBSERVATIONS

Fifty eight patients were investigated in this study. All of them presented with chronic diarrhoea and were fit to the criteria laid down for the clinical diagnosis of malabsorption. On further follow up and investigations, 12 patients had an associated secondary malabsorption. Two other patients also have steatorrhoea. But obvious cause was not found but patients responded to antibiotics. The results can be conveniently presented as under

1. Clinical observations.
2. Laboratory investigations(Table 6 to 12).

CLINICAL OBSERVATIONS

Out of 58 patients, 40 patients belonged to low income group and their diet was judged to be poor. rest 18 patients were low middle income group and were taking fairly nourished diet. All patients were from near by Jhansi from neighbouring villages (Table 3).

Duration of Symptoms

Intervals between the onset of symptoms and time when they were investigated shown in table 4.

Most of them presented themselves for the first time, but a proportion of them had been received antiamoebic treatment with partial or no relief of

symptoms. This interval ranged from 3 months to more than 2 years, but majority of them presented within 12 months.

Symptomatology

Diarrhoea :

Being one of the major criteria for selection of cases, was present in all the cases. Mostly patients volunteered the history of diarrhoea, while some patients admitted in on direct questioning. Severity of diarrhoea ranged from 2 stool to 15 per day. More frequent was 3-5 motions a day. Usually severity of diarrhoea varied from time to time. Stool were usually described as semisolid but during the relapses patients often had liquid stool and 4 cases they were frothy frequently the bulk was greatly increased and the stool were thought to be excessively foul smelling. Only ten patients described the colour pale otherwise stools were of normal brownish colour.

Two patients had bleeding piles, no other patient passed blood in the stool, mucus was present in 10 cases.

Usually the stool were passed at varying times through out the day. In a few patients diarrhoea was worse in the morning or after meals.

Loss of Weight

Being the second major criteria for selection of cases, was present in all cases. In 11 cases, it was slight. In all the rest, it ranged from moderate to quite significant loss. It was difficult to know the exact loss in terms of kilograms or exact duration over which it occurred.

History of abdominal pain was present in 26 patients (44.8%), 20 patients described as a constant pain experienced diffusely all over the abdomen. It has no definite relationship to food in majority of them. It was intermittent and colicky in 4 patients. Pain was usually mild to moderate, 2 patients complained of vague discomfort in the abdomen rather than pain.

Eighteen patients complained of occasional distension of abdomen, which was more marked after meals. They also complained of excessive borborygmi.

Pallor

Due to anaemia, was present in all the 58 cases. But was more marked in 14 cases, whom steatorrhoea was shown. Asthenia weakness and lassitude also occurred in all cases, but it was more comparatively in steatorrhoea patients. It varied in severity from patient to patient and put to patient to bed.

Nausea and Vomiting

Nine (64.2%) patients had complained of nausea and vomiting at one or the other stage of their illness. These were presented, frequently with steatorrhoic patients but not in other patients.

Appetite

Appetite was definitely reduced in 10 patients (71.4%) out of 14 patients (steatorrhoiec patients). In 2 patients had excessive appetite (14.28%). Remaining 2 patients had fair appetite. Overall in 58 patients appetite was reduced 50% cases.

Glossitis or Stomatitis

It was present in 5(35.7%) patients. Swelling of feet was present in 3(21.4%) in malabsorptive patients.

Parasthesia and pain in calf muscles was present in one(7.14%) case. Patient had tender calf muscle.

Signs

Emaciation

Associated with evidence of weight loss and muscular weakness was present in all the cases. It was slight in two, moderate in four and quite significant in rest eight patients.

Hypertension

Systolic blood pressure around 100 mm Hg was encountered quite frequently. Some (4) patients had postural hypotension as well.

Early Clubbing was present in 2 patients.. Skin changes, loss of elasticity and dryness of skin was frequently seen. Pigmentation was observed in 2 cases.

TABLE 1 : Age and sex distribution of the patients.

Age groups (years)	Male	Female	Total
10 - 20	4	3	7
21 - 30	6	8	14
31 - 40	14	9	23
41 - 50	7	4	11
51 - 60	1	1	2
61 & above	1	-	1
TOTAL	33	25	58

TABLE 2 : Age and sex distribution of controls.

Age group (years)	Male	Female	Total
10 - 20	2	1	3
21 - 30	2	2	4
31 - 40	5	3	8
41 - 50	3	2	5
TOTAL	12	8	20

TABLE 3 : Age and sex distribution of different aetiological conditions.

Aetiology	Number of cases			Age in years		Percentage
	Male	Female	Total	Range	Mean	
Undetermined	2	-	2	36-47	41.5	14.30
Tubercular enteritis	3	2	5	23-60	32.4	35.70
Ulcerative colitis	-	1	1	22	22.0	7.10
Ulcerative colitis + giardiasis	1	-	1	42	41.0	7.10
Obstructed jaundice	1	1	2	23-27	25.0	14.30
Cirrhosis of liver	1	-	1	40	40.0	7.10
Chronic Pancreatitis	1	1	2	14-60	37.0	14.30
TOTAL	9	5	14		35.7 ± 6.2	

TABLE 4 : Duration of symptoms in patients.

Duration (months)	No.of cases
3 - 6	40
7 - 9	8
10 - 12	7
13 - 24	2
7 24	1
TOTAL	58

TABLE 5 : Malabsorptive patients and etiological diagnosis.

Sl. No.	Case No.	Age/Sex (years)	Salient clinical features	Laboratory features and management	Etiological diagnosis
1.	6	60/M	- Fever mild grade, 3 months - Loss of weight, 3 months - Diarrhoea, 3 months - Cervical lymphadenopathy (Matted), 1 month - Multiple nodular masses in abdomen.	ESR - 50 mm in 1st hour Lymphanode Biopsy - Tubercular lymphadenitis Satisfactory response to antitubercular treatment	Takes Mesenterica
2.	10	24/F	- Off & on fever. 1 year - Cough with expectoration with blood in sputum off & on 1 year - Pain in abdomen 3 months - Diarrhoea 3 months	ESR - 60 mm in 1st hour X-ray chest PA view-Tubercular infiltration. Satisfactory response to antitubercular treatment.	Koch's lung Koch's abdomen.
3.	13	32/M	-IRregular fever 8 months - Diarrhoea (Alternating with constipation) 8 months	Radiological evidence of strictures of small intestine with intervening dilated loops, extensive peritoneal adhesions. Good response to antitubercular treatment.	Tubercular enteritis
4.	16	42/M	- Loose motions containing blood and mucous 7 months - Marked weakness 5 months. - Loss of weight 5 months.	Sigmoidoscopy - hyperaemic and granular mucous membrane. Stool contain - giardiasis ova and trophozoits. Satisfactory response to anti-ulcerative colitis treatment.	Ulcerative colitis with giardiasis

Contd....

5.	17	22/F	- Loose motions with blood with mucous | 6 months - Marked weakness -Loss of weight | 5 months	Signoidoscopy - hyperaemic and granular mucous membrane. Barium enema - loss of haustration pseudopolyposis. Responsed to 5-aminosalicylic acid and metronidazole.	Ulcerative colitis
6.	20/	27/M	- Attacks of pain right abdomen | 5 years - Jaundice - Foul smelleing clay colour stool | 3 mo.	Serum bilirubin - 30 mg% Urinary Urobilinogen - absent Sr. alkaline phosphatase-53 KAU Plane X-ray abdomen - Gall stone Ultrasounds upper abdomen -Cholelithiasis.	Cholelithiasis with obstructive jaundice.
7.	24	23/F	- Progressive yellowness | 3 mo. - Clay coloured stool itching | 1 month	Serum bilirubin - 18 mg% S. Alkaline phosphatase - 82 KAU Ultrasound abdomen - Dilated CBD.	Obstructive jaundice
8.	31	40/M	- Diarrhoea - 4 mo. - Marked weakness - Swelling over abdomen and feet. H/O haematemesis. Spleen - 3 finger enlarge ascites(+), distention of veins around the umbilicus.	<u>Liver function tests</u> : Moderate impairment of liver functions. Total plasma proteins - 4.4 mg% Albumin - 2.4 gm%. Globulin- 2.0 gm%	Portal cirrhosis
9.	44	60/M	- Recorrent attacks of pain in abdomen x 4 months - D$arrhoea off & on - 3 mo. - Mass in epigastrium- 1 mo. - Loss of appetite -1 mo.	Serum amylase - 300 Somogyi unit% X-ray abdomen - calcification seen	Chronic pancreatitis
10.	47	14/F	- Off & on pain in abdomen (Mod. to Severe) - 8 mo. - Diarrbea - 3 months. - Mass in epigastrium.	Sr. Amylase 480$ units. X-ray abdomen - calcification Ultrasound - pseudopancreatic cyst.	Chronic pancreatitis

11.	51	25/F	Fever Abdominal pain Diarrhoea	6 months	ESR - 60 mm in 1st hour Treated with antitubercular treatment for 9 months with excellent symptomatic response.	Koch's abdomen
12.	53	23/M	- Fever off & on - Pain in abdomen - Loose motion alternating with constipation.	6 mo 3 mo	ESR - 44 mm in 1st hour Barium follow through - Ilio-cecal region shows obstruction. Treated with antitubercular treatment Improved - symptomatically.	Iliocecal tubercu-losis
13.	35	36/M	- Loose motion with blood with mucous - Foul smelling stool - Pain in abdomen (mild to mod.	4 mo.	Symptomatically responded with metronidazole and tetracycline for 2 months, folic acid, iron.	Most probably bacterial over growth
14.	58	47/M	- Loose motion - Foul smelling stool - Pain in abdomen (after taking meal	3 months	U.G.I. endoscopy - NAD Symptomatically responded with tetracycline x 2 months. folic acid, iron.	Most probably bacterial over growth

TABLE 6 : Results of haematological investigations.

Sl. No.	Hb gm% (14-18)	PCV(%) (40-47)	R.B.C. m/cmm. (4.4-6.1)	M.C.H. M.M.gm (27-32)	M.C.V. (Cubic micron (78-94)	M.C.H.C. (%) (32-38)	Peripheral blood(type of Anaemia)
1.	7.0	22	2.30	30.4	72.3	31.8	Microcytic
2.	8.4	28	3.50	24.0	80.0	30.0	Normocytic
3.	10.0	30	3.40	29.4	88.2	33.3	Normocytic
4.	10.2	32	3.90	26.0	82.0	31.8	Normocytic
5.	9.0	34	2.80	32.1	121.4	26.4	Macrocytic
6.	5.5	17	2.94	18.9	57.8	32.3	Microcytic
7.	7.0	24	3.45	20.2	69.5	29.2	Microcytic
8.	9.6	30	2.90	33.1	103.4	32.0	Macrocytic
9.	6.4	31	2.60	24.6	119.2	20.6	Macrocytic
10.	7.8	21	2.40	32.5	87.5	37.1	Macrocytic
11.	7.0	24	2.60	26.9	92.3	29.1	Normocytic
12.	8.0	22	3.82	21.0	57.5	36.3	Microcytic
13.	8.2	36	3.00	27.6	120.0	22.7	Macrocytic
14.	6.2	28	2.40	25.8	116.6	22.1	Macrocytic
15.	7.5	28	2.60	28.8	107.6	26.7	Macrocytic
16.	11.6	34	4.20	27.6	80.9	34.1	Normocytic
17.	7.5	28	2.46	30.4	113.8	26.7	Macrocytic
18.	6.5	20	2.60	25.0	76.9	32.7	Microcytic
19.	6.0	22	2.42	24.7	90.9	27.7	Normocytic
20.	6.2	18	2.44	25.4	73.7	34.4	Microcytic
21.	9.4	30	2.50	37.6	120.0	31.3	Macrocytic
22.	9.0	27	3.30	27.2	81.8	33.3	Normocytic
23.	6.8	29	3.90	17.4	61.5	28.3	Microcytic
24.	8.0	24	2.94	27.5	81.6	33.3	Macrocytic
25.	6.5	21	2.40	27.0	87.5	30.9	Normocytic
26.	10.5	33	3.00	35.3	110.0	31.8	Macrocytic
27.	6.5	20	2.40	27.0	83.3	32.5	Normocytic
28.	6.0	20	2.46	24.4	81.3	30.0	Normocytic
29.	5.5	18	2.48	24.1	72.5	30.5	Microcytic
30.	6.0	22	2.72	22.0	80.8	27.2	Normocytic
31.	5.8	18	2.40	24.1	75.0	32.2	Microcytic
32.	6.2	24	2.91	21.3	82.4	25.8	Normocytic

33.	5.5	20	2.72	20.2	73.5	27.5	Microcytic
34.	6.0	22	2.92	20.6	75.3	27.2	Microcytic
35.	6.5	26	2.40	27.0	108.3	25.0	Macrocytic
36.	10.6	33	3.90	27.1	84.6	32.1	Normocytic
37.	6.5	22	3.80	17.1	57.8	29.5	Microcytic
38.	8.0	24	3.40	23.5	70.5	33.3	Microcytic
39.	6.8	25	3.30	20.6	75.7	27.2	Microcytic
40.	9.0	27	3.39	26.5	79.6	33.3	Normocytic
41.	9.4	36	3.48	27.0	103.4	26.0	Macrocytic
42.	6.2	24	2.90	21.3	82.7	25.8	Normocytic
43.	6.5	26	3.20	20.3	81.2	25.0	Normocytic
44.	6.0	24	2.81	21.3	85.4	25.0	Macrocytic
45.	4.8	38	4.48	26.3	84.8	31.0	Normocytic
46.	7.5	26	2.80	26.8	92.8	28.8	Normocytic
47.	6.2	20	2.40	25.8	83.3	31.0	Normocytic
48.	8.2	24	3.20	25.6	75.0	34.1	Microcytic
49.	8.0	28	2.80	28.5	100.0	28.5	Macrocytic
50.	7.0	22	2.30	30.4	95.6	31.8	Normocytic
51.	7.8	24	2.60	30.0	92.3	32.5	Macrocytic
52.	6.4	22	2.90	22.0	75.8	29.0	Microcytic
53.	9.5	30	3.20	29.6	93.7	31.6	Macrocytic
54.	9.6	34	3.40	28.2	100.0	28.2	Macrocytic
55.	7.0	22	2.90	24.1	75.8	31.8	Microcytic
56.	6.5	26	2.80	23.2	92.8	25.0	Normocytic
57.	10.0	30	3.90	25.6	76.9	33.3	Microcytic
58.	10.6	28	3.50	30.2	80.0	37.8	Microcytic

	Steatorrhoeic patients	Over all patients
Microcytic	4(28.6%)	19(32.8%)
Macrocytic	8(57.1%)	18(31.0%)
Normocytic	2(14.3%)	21(36.2%)

TABLE 7 : Results of daily fecal fat and D-xylose test (Dose-25 gms) determination in normal subjects daily fat intake - 75 gms).

Sl. No.	Age (years)	Sex	Fecal fat gm/day	D-xylose in blood after 2 hour (mg%)
1.	18	M	3.2	40
2.	24	M	3.1	30
3.	16	F	4.2	110
4.	28	F	4.0	40
5.	20	M	3.6	68
6.	28	M	3.0	32
7.	31	M	4.3	50
8.	34	M	3.2	40
9.	21	F	4.2	48
10.	36	M	4.6	46
11.	40	M	4.9	28
12.	32	M	3.6	42
13	32	F	3.7	60
14.	38	F	4.0	64
15.	31	F	4.0	32
16.	44	M	4.2	56
17.	48	M	4.9	45
18.	50	M	4.4	35
19.	45	F	4.2	34
20.	46	F	4.8	30
Mean	33.1		4.0	46.5
±SD	±10.3		±0.6	±19.0
Range	16.50		3.0-4.9	28-110

TABLE 8 : Results of daily fecal fat and D-xylose absorption test determination in patients. Normal daily fecal fat per day = ⁄5 gm. Normal D-xylose absorption value = 722.

Case No.	Age/Sex (Years)	Fecal fat gm/day	D-xylose in blood after 2 hour (mg%)
1.	16/M	4.2	75
2.	33/M	4.0	30
3.	38/M	3.6	50
4.	40/F	4.8	60
5.	18/M	2.2	28
6.	60/F	5.5	32
7.	42/M	3.8	30
8.	46/M	2.1	34
9.	43/M	2.4	35
10.	24/F	13.0	18
11.	26/M	2.8	45
12.	28/M	3.1	56
13.	32/M	14.0	12
14.	22/M	3.4	32
15.	18/F	3.6	64
16.	42/M	7.0	11
17.	22/F	26	10
18.	24/M	3.8	60
19.	47/M	3.8	42
20.	27/M	5.0	35
21.	48/M	2.3	30
22.	26/F	3.2	38
23.	44/M	4.0	34
24.	19/F	1.6	18
25.	35/F	2.8	70
26.	23/F	6.6	78
27.	36/F	3.6	40
28.	35/M	3.6	44
29.	32/M	4.2	28
30.	39/M	4.3	46

Contd .....

31.	40/M	5.3	58
32.	38/F	3.2	48
33.	40/M	2.1	40
34.	32/F	3.4	50
35.	36/M	6.0	34
36.	35/F	3.0	42
37.	37/M	4.3	24
38.	26/F	3.4	29
39.	17/M	1.2	38
40.	33/M	3.3	24
41.	38/F	1.4	56
42.	31/M	2.2	88
43.	28/F	3.6	90
44.	60/M	6.0	22
45.	16/M	6.6	118
46.	32/F	1.8	32
47.	14/F	8.0	16
48.	34/F	1.9	72
49.	24/F	2.8	84
50.	41/M	1.6	48
51.	25/F	8.0	20
52.	29/F	2.9	72
53.	23/M	7.5	36
54.	42/M	1.2	94
55.	39/M	3.9	26
56.	46/M	4.0	54
57.	32/M	2.8	56
58.	47/M	5.6	30
Mean ±SD	33.1 ±10.4	4.40 ± 3.70	44.67 ±22.70
Range	14-60	1.2-26	10-118

Abnormality of fecal fat test : 14/58 (24.13%)

Abnormality of D-xylose test : 7/58 (12.06%)

TABLE 9 : Comparison of results of daily fecal test (abnormal) and D-xylose test in patients.

Normal daily fecal fat per day = ⟨5 gms.

Normal D-xylose test after 24 hours in blood = 722 mg%

Sl. No.	Case No.	Fecal fat gm/day	D-xylose test in blood after 24 hours (mg%)	Result
1.	6	5.5	32	-
2.	10	13.0	18	+
3.	13	14.0	12	+
4.	16	7.0	17	+
5.	17	26.0	10	+
6.	20	5.0	35	-
7.	24	6.0	18	+
8.	31	5.3	58	-
9.	35	6.0	34	-
10.	44	6.0	22	-
11.	47	8.0	16	+
12.	51	8.0	20	+
13.	53	7.5	36	-
14.	58	5.6	30	-
Mean ±SD		8.78 ±5.67	25.57 ±12.80	
Range		5.0-26.0	10-58	

Mean age = 33.6 years, Age Range = 14-60 years

Positive results = 50%, M : F = 4 : 3.

TABLE 10 : Clinical nutrition assessment and laboratory findings.

Sl. No.	Case. No.	Clinical nutritional status of patient	Roent. exam.	Fecal test	D-xylose test
1.	6	Poor	+	+	-
2.	10	Fair	+	+	+
3.	13	Fair	+	+	+
4.	16	Fair	+	+	+
5.	17	Fair	+	+	+
6.	20	Fair	±	+	-
7.	24	Fair	-	+	+
8.	31	Fair	±	+	-
9.	35	Fair	-	+	-
10.	44	Poor	+	+	+
11.	47	Fair	+	+	+
12.	51	Fair	±	+	+
13.	53	Fair	+	+	-
14.	58	Fair	±	+	-
			+ 57.1%	+ 100%	+ 50%
			- 14.3%		- 50%
			± 28.6%		

* Criteria for clinical nutritional status of patients for poor - Cachecia, Diarrhoea, Avitaminosis.

TABLE 11 : Comparison of two diagnostic tests in patients(percentage of positive results).

Test	Abnormality	
	No.of cases	Percentage
Fecal test	14	24.13
D-xylose test	7	12.06

1. t = 0.6025619, p = 0.05 Not significant.

2. t = 0.3196413, p = 0.05 Not significant.

TABLE 12 : Comparison of two diagnostic tests in 14 patients (steatorrhoea).

Test	No.of cases	Percentage
Roentgenogram Examination		
- Strongly positive	8	57.14
- Possible positive (equivocal)	4	28.60
D-xylose	7	50.00

D I S C U S S I O N

D I S C U S S I O N

Malabsorption and maldigestion are significant causes of morbidity and mortality throughout the world. Malabsorption can result from a large number of diseases. Incidence and prevalence may vary according to geographically variation.

In third world countries infections of the gastroentestinal tract are common causes of malabsorption syndrome.

A number of disorders result in malabsorption of one or more of the essential nutrients electrolytes, minerals or vitamins. Some or all of the following features may ensue, - diarrhoea, abdominal pain and distension loss of weight, anaemia or other evidence of specific deficiency. However, some patients complained only of vague ill-health and the diagnosis may not be made for many years.

Malabsorptive disorders can be classified according to whether the primary disturbance is within the intestinal lumen due to insufficiency of digestive enzymes or bile acids, or within the intestinal mucosa. In disorder of intraluminal digestion which include pancreatic insufficiency (chronic pancreatitis, cystic-fibrosis, carcinoma of pancrease). Defficiency of bile acids (interuption of the enterohepatic circulation of

bile acids due to resection or disease of the terminal ileum, colonisation of small intestine with bacteria which deconjugate bile acid which reduces their efficiency, stagnant loop syndrome) uncoordinated gastric emptying which delivers gastric chyme too quickly to the intestine (gastroenterostomy, partial gastrectomy). Disorder of transport in the intestinal mucosa in which include, generalised mucosal abnormalities, the mucosa is abnormal histologically (Coeliac disease, tropical sprue, lymphoma, Whipple's disease, radiation enteritis). Malabsorption of specific substances in which mucosa is normal histologically (lactose deficiency).

A number of signs indicates possible malabsorption :

1. Unexplained weight loss or malnutrition without ovious systemic illness (disease such as malignancy and thyrotoxicosis excluded).
2. Unexplained anaemia especially if two or more of the following are abnormal like iron, B_{12}, folate albumin.
3. Diarrhoea, with normal stool investigation, normal sigmoidoscopy and normal barium enema.
4. Osteomalasia without a dietary or renal cause.

Most of the test useful in the diagnosis of malabsorption indicate the presence of abnormal absorption or digestive function and only a few test may suggest

a specific diagnosis. Accordingly, it is frequently necessary to employ a combination of tests to establish a diagnosis.

In our study, out of 14 proved cases of malabsorption, there were 5(35.7%) cases of tuberculosis, 2(14.3%) cases of obstructed jaundice, two (14.3%) cases of chronic pancreatitis, 1(7.1%) case of cirrhosis of liver, 1(7.1%) case of ulcerative collitis and other one ulcerative collitis with giardiasis (7.1%), 2 cases remained undetermined (14.3%), but responded to antibiotic, most probably they would be cases of bacterial over growth. 14 proved cases of malabsorption mean age was 35.7±6.2 years. Range was 14-60 years and male : female ratio was 9 : 5. (Table 3)

While some relevant incidental observations were made during the study and are discussed in brief in the following paragraphs.

AGE AND SEX INCIDENCE

Average age of control group (20 cases) was 33.1±10.3 years with range of 16-50 years. Male : female ratio was 3 : 2. (Table 2).

Mean age of patients (58 cases) was 33.1±10.4 years with range of 14-60 years and male to female ratio was 33 : 25 years (Table 1).

Mean age of steatorrhoeic patients was 33.6± 14.5 years with range of 14-60 years. Male : female ratio was 4 : 3 (Table 9). Comparative findings were reported by Baker (1962) from a study of 60 cases of chronic unexplained diarrhoea with secondary nutrition deficiencies. The mean age of the patients with secondary malabsorption syndrome was 34.5% years. No significant sex difference was observed and male : female ratio was being almost equal to in number 9:8.

SOCIAL STATUS

All patients came from neighbouring villages of Bundelkhand region, Jhansi, Central India. All of them belonged to low to lower middle income group and were on a poor diet.

ALTERED BOWEL HABIT

For three months or longer, the symptoms of anemia were common to all patients,, Ranging from mild to severe (Table 4).

ABDOMINAL PAIN

Mild to moderate abdominal pain was present in 50% of cases. 3 patients had moderate to severe pain.

Irregular fever anusea, vomiting and loss of appetite were vaguely present in 50-60% cases. Infact severe abdominal pain associated with these symptoms always suggested an organic gastrointestinal disorders.

GLOSSITIS AND STOMATITIS

Glossitis and stomatitis were observed in 30% cases. Green and Willaeger (1960) and Cook et al (1953) recorded glossitis in 86% and 90% of their cases of sprue and idiopathic steatorrhoea respectively.

OEDEMA

It was observed in 21% cases. This incidence was less than that reported in the series of Green and Wallaeger (1960) and Cook et al (1953).

PARASTHESIAS

With signs of peripheral neuritis parasthesias were observed in 1 case only. Pigmentation over dorsum of hand were seen in 20% cases.

HAEMATOLOGICAL STUDIES :(Table 6)

All the patients were anaemic. Morphologically speaking from absolute values only 3 patients had mean corpuscular volume more than 94 cubic mciron. But macrocytosis as observed from the peripheral blood film was present in 8 (57.1%) cases of malabsorption. Cook et al (1953) observed macrocytosis in two thirds of their 100 cases of idiopathic steatorrhoea. Perez Santiago and Butterworth (1957) have also reported high incidences of macrocytosis in their cases of tropical sprue. Although over all patients had 18(31%) cases macrocytosis.

Measuring faecal fat, the qualitative examination of the stool, for undigested muscles fibres neutral fat, and split fat is a simple and reliable screening test for steatorrhoea. Stool appearance (Bulky, floating malodorous stools) and volume may helpful (a daily stool output less than 150 gm effectively rules out malabsorption). The finding of an increased number of muscle fibres indicates impaired intraluminal digestion, properly performed the qualitative microscopic examination of a stool specimen with the sudan III stain is of value and correlate well with the quantitative determination of fecal fat by the Vande Kamer method. This microscopic technic appears to be very adequate for demonstrating varying degree of steatorrhoea and is a good screening procedure (Drummey et al, 1961). It is also reliable inexcluding steatorrhoea in children over the age of 3 months (Ghosh et al, 1977). Stool microscopy using oil Red O to stain fat globules had a sensitivity of 72.2% and specificity of 95.4% (Teh lipbin et al, 1983).

The definitive "Gold standard" test with which to establish the diagnosis of malabsorption is the quantitative determination of fecal fat in stool described by Vande Kamer et al (1949), has been shown to be as accurate as gas liquid chromatography in quantifying fecal fat (Finley and Davidson, 1980).

Fecal fat excretion is increased under several physiologic condition like when the diet is high in fibre (7100 gm/day) (Levine and Silvis, 1979). When dietary fat is ingested in solid form such as whole peanuts (Levine and Silvis, 1980). In the neonatal period when intraluminal levels of pancreative lipase and bile salts are low (Finley and Davidson, 1980).

The fecal fat concentration - fecal fat(gm/day) divided by stool wet weight (gm/day) multiplied by 100%, may provide a clue to the cause of the steatorrhoea. Steatorrhoea secondary to pancreatic insufficiency or hepatobiliary fecal fat concentration (79.5%, normal - 7% on the average than patients with other conditions (Bo Linn and Fordtran, 1984; Robert et al, 1986).

Once the presence of steatorrhoea is confirmed, the next step is to determine the caused by disease of the intestinal mucosa or by abnormalities of intraluminal digestion. To distinguish between these possibilities several other test are helpful. But these other tests were not feasible in our institution.

FECAL FAT DETERMINATION

In our study, daily fecal fat values determined in 20 control subjects over a dietary intake of 75 gm fat per day, ranged between 3.00-4.90 gm/day with a mean ±SD of 4.0±0.6 gms. Age range was 16-60 years and mean ±SD was 33.1±10.4 years (Table 7).

Frazer (1955) used a similar method of fecal analysis stated that in normal persons on a diet containing 50-150 gms of fat per day. Fecal fat should be 5 gms or less. Pimparker et al (1961) also used a similar technique reported the normal as being 7 gms or less of fat per day.

Backer (1962) recorded that fecal fat excretion in 15 normal subjects on a daily fat intake of 50 gms ranged between 1 to $\angle$5 gms.

In our study, clinically suspected malabsorption patients (58 cases) on whom daily fecal fat determined were made. 14(24.13%) patients excreted more than 5 gms of fat per day. The mean excretion of fat per day in patients with steatorrhoea as 8.78$\pm$5.67 gm/day with range of 5.0-26.0 gms/day, age range : 14-60 years with mean age of 33.6$\pm$14.5 years (Table 8 and 9).

Comparing patient to patient there was little correlation between the degree of steatorrhoea and clinical state of the patient or number of stools passed per day.

Perez Santiago and Butterworth (1957) used the technique of Va de Kamer and reported fat excretion of over 5.5 gm/day. But rarely above 20 gms in many patients with sprue, but not all. In our study there was no any patient in which fecal fat was normal but D-xylose was abnormal. But a study in Delhi (1965) by Mangia who showed that 2 patients had daily fecal fat less than 5 gm

with definite impairment of a D-xylose absorption and equivocal radiological signs of sprue. pattern, whether or not these patients showed be included in malabsorption syndrome was difficult to decide. Similarly it was difficult to explain abnormal D-xylose absorption in absence of steatorrhoea. The consideration that chronic anaemia (both patients were anaemic) can impaired the cellular metabolism of intestinal mucosa and gave rise structural and functional defects was one of the possibilities. Unfortunately, intestinal biopsies were not done in those patients.

In our study, one female, 22 years (case No. 7) had more than 20 gm of fecal fat/day. She was diagnosed ulcerative colitis. But this to much steatorrhoea (26 gm/day) was not explained. Unfortunately jejunal biopsy facilities are not available in our institution. So it was not possible. But she responded well to anti ulcerative collitis treatment.

In our study over all fecal fat mean $\pm$ S.D. was 4.4 ± 3.7 with range of 1.2 to 26 gm/day (Table 8).

D-XYLOSE TEST

Many workers have stressed that D-xylose test is more specific of intestinal carbohydrate metabolism malabsorption than the traditional glucose tolerance test (Gardner and Perez Santiago, 1956, Benson et al,1957).

It was abnormal in over 90% of patients with steatorrhoea of intestinal origin particularly the primary malabsorption (Fourman, 1948). reported 3 cases each of idiopathic steatorrhoea and tropical sprue in all of which D-xylose excretion was decreased.

D-xylose test is one of the most useful way to examined the absorption integrity of the intestinal mucosa. D-xylose is a pantose sugar that requires on intraluminal digestion and is absorbed from the small bowel via the same transport mechanism as glucose. In addition, it is not appreciably metabolised once absorption occur and is excreted unchanged in the urine. The usual dose is 25 gm administered orally. 5 hours urine xylose excretion of 4 gm or greater is considered normal (Benson et al, 1957; Shamaa, Ghazanfar, 1960). Low values may be obtained in patients with ascites, intestinal overgrowth, or renal insufficiency, after administration of certain drugs (asprin, indomethacin) and most commonly if the urine collection is incomplete. To prevent difficulties in interpreting the test, it is advisable to determine the blood xylose level 2 hours after ingestion to xylose. A blood xylose level of 30 mg/dl or greater indicates normal absorption of D-xylose. An abnormal D-xylose absorption test is found most frequently in disorders affecting the mucosa of the proxymal small intestine such as non tropical and tropical sprue.

The D-xylose absorption test is a basic simple test used during the last 40 years for the evaluation of small intestinal absorption (Fourman, 1948).

The pediatric patients, volume urine collection is problematic xylose absorption was monitored using the 1 hour serum concentration (Hawkin, 1970; Buts et al, 1978).

Another modification involved using 5 gm instead of 25 gm xylose (Santini et al, 1961). Graig and coworkers introduced a new approach to the evaluation of the D-xylose test by infusing 10 gm of xylose, a week apart from the 25 gm oral test. Multiple blood samples were taken through out both stages (Craig et al, 1983 and Atkinson, 1988).

They showed that total amount of xylose absorbed by related to 5 hour urine xylose with a high correlation coefficient. In addition they showed that the 1 hour serum test correlated highly with the rate constant for intestinal absorption. On these basis of these kinetic studies the authors suggested that the 1 hour serum might be used clinically to assess small intestinal malabsorption where as 5 hour urine test would be abnormal not only under these circumstances but in situation where there would be increased non absorptive loss of xylose. Kwaitt and Beeton (1975) and Bode and Gudmand Hoger (1987) recommended abandoning the xylose absorption test

on the grounds of it being nonspecific. Sladen and Kumar suggested omitting the test in cases where jejunal biopsy is feasible(Sladen&Kumar , 1973). As yet there is no complete agreement on the most accurate way to perform the xylose absorption test in adult patients(Zarling, 1988). However the test is still considered by most investigators as an important and reasonably sensitive one. A study by Peled et al (1991) D-xylose absorption test urine or blood they suggested that in adults the 5 hour urine collection more accurately reflects intestinal absorption in comparison with one hour blood value. In a study D-xylose test in coeliac disease abnormal levels were found in 98% of total or subtotal villous atrophy. It was suggested to apply this test for screening in severe cases (Hedvig et al, 1983).

Since with increasing age the absorption of xylose improves this to be considered when evaluating the test. D-xylose test serves as an indication for small bowel biopsy. An abnormal D-xylose test after introduction of the gluten free diet points to its deficiency.

In another study from Vellore, South India Rolston and Mathew (1989) suggested that jejunal D-xylose absorption at concentration used clinically, is by passive diffusion, which process completely over rides a minor D-xylose cotransport component. The D-xylose tolerance test, therefore, reflects jejunal mjcosal

surface area and mucosal permeability to D-xylose and not nutrient carbohydrate absorption.

A study anti-gliadin antibody pannel and xylose absorption test in screening for celiac disease. Edward and Dennis (1990) recommended screening with the AGA panel with obtaining a xylose test if only the IgG is abnormal biopsy should be performed in cases with high IgA. IGA or with abnormal IgG, AgA and xylose values. This approach is clinically preferable, does not add cost, and spares children from unnecessary small bowel biopsies. Screening test for carbohydrate malabsorption three test have been recommended (1) postprandial breath hydrogen production, fecal reducing substance, and fecal pH. Although all three test have limitations, the hydrogen breath test is the most useful and versatile in evaluating various types of carbohydrate malabsorption. This test is relatively simple, sensitive specific non-invasive and applicable to any age group (Newcomer, 1984).

Another study Rice Flour breath hydrogen and malabsorption by Paul et al (1984) proposed if indeed rice flour is well absrobed. It may provide a simple safe and noninvasive method to investigate carbohydrate absorption in a variety of diseases commonly associated with malabsorption.

In our study in which 58 suspected malabsorption clinically D-xylose test was abnormal in only 7(12.06%) cases. These all were steatorrhoic patients. In other

there was no case who has negative fecal fat test but positive D-xylose absorption test. We can say that in steatorrhoea patient, 50% patients have positive D-xylose test (Table 8). Included in those with impaired D-xylose absorption were patients with Koch's lung with Koch's abdomen or tubercular enteritis, ulcerative colitis with giardiasis, obstructed jaundice, chronic pancreatitis, Koch's abdomen.

In one (case No.44) was diagnosed a chronic pancreatitis has marginal value that is 22 mg%. In other steatorrhoic patients D-xylose test was negative.

In infiltrating condition of small intestine like tuberculosis, an abnormal D-xylose test would suggest mucosal damage rather lymphatic obstruction. In lymphatic obstruction only, as in intestinal lymphangiectasia. Waldmann et al (1961) have reported normal D-xylose absorption.

Impaired D-xylose absorption in the patient with cirrhosis and ascites is explained due to sequestration of a proportion of D-xylose in the ascitic fluid (Prokipchuk et al, 1961).

Normal or marginal result are however, obtained in pancreatic insufficiency (as in case No. 44) and is of value in differentiating pancreatogenous from intestinal steatorrhoea.

In ulcerative colitis with giardiasis an abnormal D-xylose test was not explanable.

In controlled group (20 cases), age ranged 16-50 years with mean±SD 33.1±10.3 years. D-xylose value range from 28-110 mg% with mean ±SD 46.5±19.0 (Table 7).

In a one female age 16 years D-xylose value was quite high that is 110 mg% we have no any explanation for that.

In patients group over all patients considering D-xylose test range was 10-118 mg% with mean ±S.D. 44.67±22.7 mg%.

In patients group one male age 16 years has quite high value of D-xylose test, we were not able to explain the cause.

In the light of above results, D-xylose test cannot be considered as diagnostic of malabsorption syndrome.

ROENTGENOLOGICAL STUDY

All patients with malabsorption should have radiographic examinations of the small intestine and, in many cases of the esophagus, stomach and colon as well occasionally the latter two examinations may provide important clues to the presence of such disorders as gastroileostomy, scleroderma, Zollinger-Ellison syndrome ulcerative colitis, and intestinal fistulas. Traditional radiographic findings suggesting a diagnosis of

malabsorption include floculation of barium within fluid filled loops, causing fragmentation and sigmentation of barium coluwn. However, these patterns are no longer demonstrated reliably in small bowel series because of wide spread use of barium products, that contain a non-floculating suspension of micropuluerized barium sulfate. In non tropical sprue, the most consistent abnormalities are thickened and nodular duodenal folds and dilatation of the small bowel. However, these findings are non-specific and may be found in several of the disorders.

Radiologic manifestations of malabsorption : A non specific finding, study by Weizman et al (1984). Children demonstrating a radiologic malabsorption pattern of small bowel follow through study performed for other reasons are frequently subjected to intestine gastroen-testinal investigations, even in the absence of clinical manifestation of malabsorption. Thirteen patients ful-filled the criteria for radiological malabsorption patterns, but six(4.6%) had no clinical evidence of mal-bsorption, according to 3-5 days fecal fat analysis.

In addition, five of these patients had normal mucosal histological findings on duodenal biopsy. It was concluded that radiologic malabsorption pattern is a nonspecific finding, and in the absence of other clinical features suggestive of malabsorption or growth failure further investigations may not be justified.

In our study, the changes in barium meal study of small intestine included dilatation, sigmentation, fragmentation thickening of mucosal folds. The commonest were sigmentation and fragmentation but dilatation of jejunal loops and coarsening of mucosal folds were also frequently seen.

Abnormalities were observed in steatorrhoeic patients, 8 patients had positive changes (57.1%). In four patients changes were equivocal (28.6%). Two patients had no change (14.3%) (Table 10).

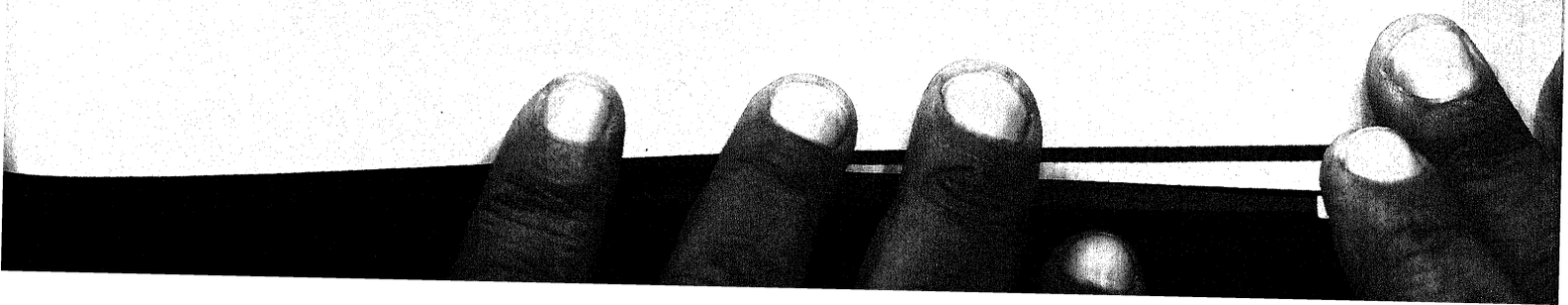
These radiological barium meal follow through were done only in steatorrhoeic patients only, not in other patients nor in control subjects.

A good correlation was observed between the degree of roentgenological change and the clinical condition of the patient. Correlation was not so well marked with the intensity of steatorrhoea.

For the purpose of comparing the results of various diagnostic technics in relation to chemical fat determinations. It would seem that D-xylose and radiologic study of small intestine constitute the most useful screening procedures. Fecal fat determinations, however, would be required for confirmation and quantitationf steatorrhoea.

Radiological study of small intestine in majority of cases showed changes when abnormal. However, these tests were of diagnostic assistance in chronic pancreatitis, localisation of lesion in enteritis, and in demonstrating intestinal stasis due to strictures.

SUMMARY AND CONCLUSION



SUMMARY AND CONCLUSION

Fifty eight patients with chronic diarrhoea and associated nutritional deficiencies were investigated for evidence of absorptive defects.

Fourteen of them had fat malabsorption. Twelve had detectable cause with tubercular enteritis (35.7%), ulcerative colitis, giardiasis (14.3%), obstructed jaundice (14.3%), cirrhosis of liver (7.1%), and chronic pancreatitis (14.3%). Remaining two had no detectable primary cause for diarrhoea and fat malabsorption. But they responded to antibiotic course.

The study included :

(i) Clinical assessment based upon history and physicsl examination.

(ii) Haematological studies.

(iii) Determination of daily fecal fat output,

(iv) D-xylose absorption test.

(v) Roentgenological studies of small intestine with barium meal.

The study revealed that the clinically suspected cases of malabsorption chemical analysis of faeces for daily total fat was not so sensitive (24.13% of 58 cases) for the detection of malabsorption though invariable always. It fail to indicate the underlying cause. In comparison to occurrence of subnormal result in other

test was :- D-xylose absorption test (12.06% in 58 cases), Roentgenologic study (57.1±28.6%) in malabsorptive patients.

In fat malabsorptive patients. according to statistical significant test both test fecal fat estimation and D-xylose test are insignificant at p = 0.05. In patients with steatorrhoea D-xylose absorption test was positive in 50%, and barium meal study result positive in 57.1% cases and 28.6% picture was equivocal.

D-xylose test did not increase the incidence of correct diagnosis. It was further observed that in patients of malabsorption syndrome the radiological examination of the small intestine gave abnormal results with one or more tests in 50%cases.

No constant correlation could be demonstrated between the severity of steatorrhoea and the results of D-xylose test and roentgenologic study. We had not used any test in differentiating pancreatogenous from intestinal malabsorption in a case of chronic pancreatitis.

In conclusion the result of this study indicate that though chemical determination of fecal fat is a "Gold standard" test, for malabsorption syndrome, yet the study of malabsorption does not correlate well with clinical features. We recommend, before doing quantitative test, other valuable screening procedure for malabsorption should be done like microscopical examination of the stool for steatorrhoea, which is a

valuable screening procedure in detection of malabsorption syndrome. It shouwed an error 11 to 14 percent (Weijers and Van de Kamer, 1953). The use of continuous marker provides a method for assessing the degree of steatorrhoea on a single stool sample without the disadvantages of the conventional method of fecal fat analysis.

If screening results are positive, a quantitative determination of fecal fat should always be done to objectively confirm that malabsorption exists. If the D-xylose test and small bowel follow through are abnormal, diseases of the intestine or presence of bacterial overgrowth should be considered. The small bowel biopsy established the cause of the intestinal lesion and fluid aspirate for cultures, plus the Schilling test may suggest bacterial over growth. If the serum trypsinogen is abnormal and pancreatic calcification are present on an abdominal plain film the diagnosis of chronic pancreatitis may be made. If the calcification are absent, the bentiramide or secretin cholecystokinin tests should be performed.

Study also indicate that tuberculosis is definitely closely related to malabsorption syndrome.

B I B L I O G R A P H Y

BIBLIOGRAPHY

Adams JF, Clark JS, Iseland JT, Kessan CM and Watson WS: Malabsorption of vitamin B_{12} and intrinsic factor secretion during bigumide therapy. Diabetologia, 1953; 24 : 16-18.

Adibi SA and Stanko RT : Perspective on gastrointestine surgery for treatment of morbid obesity. The Lesson Leathed. Gastroenterology, 1984; 89 : 1381.

Ahasan Mallak, Isselyust, Yacor Ratan Uri Adar : Malabsorption syndrome, co-acidosis combined immune deficiency and fulminant lymphoproliferative disease. Arch Intern Med Jan 1982; Vol 142.

Adessn B, Floren CH : Use of the triolein breath test for the demonstration of fat malabsorption in coeliac disease. Scand J Gastroenterol, 1983; 19:307-314.

Allen RH, See Tharain B, Poddl E and Alpers, DH : Effect of proteolytic enzymes on the binding of cobalamin to R-protein and intrinsic factor. In vitro evidence that a failure to partially degrade R-protein is responsible for cabalamin malabsorption in pancreatic insufficiency. J Clin Invest, 1978; 61 : 47.

Allison HF and Bornman PC : Isolated kaposis sarcoma of the small bowel, presenting with intestinal obstruction and malabsorption. Br J Surg 1983; 70:506. Printed in Great Britain.

Ament ME Och S, Davis SD : Structure and hine of the gastrointestinal tract in primary immunodeficiency syndrome. A study of 39 patients. Medicine, 1973; 52 : 227-248.

Ament ME and Rubin CE : Relation of giardiasis to abnormal intestinal structure and hine in gastrointestinal immunodeficiency syndrome. Gastroenterology, 1972; 62 : 216.

Ament ME : Giardiasis and vitamin B_{12} malabsorption. Gastroenterology, 1972; 63 : 1085.

Amini, F : Giardiasis and steatorrhoea. J Trop Med Hyg, 1983; 66 : 190.

Amman HV and Phillips SF : Inhibition of colonic water and electrolyte absorption by fatty acids in man. Gastroenterology, 1973; 65 : 744.

Badley BWD, Murphy JM, Boucheir IHD, Sherlock S : The role of bile salts in the steatorrhoea of chronic liver disease. Gastroenterology, 1969; 56 : 1136.

Baker SJ, Igvatus M, Mathan VI, Vaist SK and Chacko CC : In Ciba foundation study group No. 14 on intestinal biopsy p-89, Little Brown and Co. Boston, Mass, 1962.

Baraova E, Orrego H, Feruander O, Amenabar E et al : Absorption function of the small intestine in liver cirrhosis. Am J Dig Dis, 1963; 7 : 318-330.

Baron JH, Hobsley M, Wormsley KG, Gastric and pancreatic exocrine secretion . J Roy Soc Med, 1981:74:386-8.

Benson JA Jr, Culver PJ, Raglands J et al : The D-xylose absorption test in malabsorption syndromes. N Engl J Med, 1957; 256 : 335-8.

Bin TL, Stopard M, Anderson S Grant A et al : Assessment of fat malabsorption. J Clin Pathol, 1983; 36 : 1362.

Birker HG, Malin JR, Reemtsma K : Study of fat and fatty acid absorption in postgastrectomy patients using radioactive labeling N.Y. state. J Med, 1960; 60: 1783-1786.

Black A, David : Malabsorption, common causes and their practical diagnosis. Geriatrics, 1986; 43; 1.Jan.

Bo Linn GW, Fordtron JS : Fecal fats concentration in patients with steatorrhoea. Gastroenterology, 1969; 8 87(2) : 319-22.

Bode S, Gudmand Hoyer E : The diagnostic value of the D-xyloe absorption test in adult caeliac disease. Scand J Gastroenterol, 1987; 22 : 1212-1222.

Boclamszky K, Horvath Horn Gabriella: The D-xylose test in coeliac disease. Acta Paediatrica Hugaria, 1983; 24(1) : 17-22.

Braddock LI, Fleisher DR and Barbosa GJ : A physical chemical study of the Van de Kamar, Method for fecal fat analysis. Gastroenterology, 1968; 55:163.

Braganza JM, Testung : Pancreatic function. Medicine International, 1982; 15 : 686-8.

Brandborg LL, Goldberg SB, Bridonbach WC Human:Coacidiosis: A possible cause of malabsorption. N. Engl J Med 1970; 283 (1306-13.

Broitman SA, Boudy DS, Yachin I : Absorption and disposition of D-xylose in thyrotoxicosis and myxoedema. N Engl J Med, 1964; 27 :333-7.

Brugge WR, Goff JS, Allen NC, Padell ER and Allen RH: Development of dual tubel schilling test for pancreatic exogenous function based on the differential absorption of cobalamin bound to intrinsic factor and R-protein. Gastroenterology, 1980; 78 : 937.

Bulter RN, Gehling NJ, Lawson MJ and Grant AK : Clinical evaluation of the C-triolein breath test : A critical analysis. Aust N. Z J Med, 1984; 14 : 111.

Burman JF, Jenkins WJ, Walkar Smith JA Phillips AD et al : Absent ileal uptake of IF bound vitamin B_{12} in vivo in the Imerslund. Grasbeam syndrome. Familial vitamin B_{12} malabsorption with proteinuria. Gut, 1989; 26 : 311.

Butterworth CE Perez, Santiago E, Martinez de Jesus J and Santini R : Studies on the oral and parenteral administration of D-xylose . N Engl J Med, 1959; 261; 157.

Carroll JE, Silverman A, Isobe Y et al : Inflammatory myopathy, IgA deficiency and intestinal malabsorption J Pediatre, 1976; 89 : 216-9.

Case records of the massachuetts General Hospital (case 20-1986) N Engl J Med, 1986; 314 : 1369.

Case records of the Massachusetts General Hospital (Case 21-1984). N Engl J Med, 1984; 310:1374.

Chanter C, Esartain P, Plaza AC : Diffuse plasma cells infiltration of the small intestine with malabsorption associated to IgA monoclonal gammopathy. Cancer, 1974; 34 : 1620-1630.

Chaudhury RN : A note of giardiasis with steatorrhoea. Indian Med Gaz. 1943; 78 : 284.

Christiansen PA, Kirsner JB, and Ablaya J : D-xylose and its use in the diagnosis of malabsorptions state. Am J Med, 1959; 27 : 443,

Corbeel L, Vanden Berghe G, Jacken J et al : Congenital folate malabsorption. Europ J Pediatr 1985;143:284.

Cooke WT, Peeney ALP and Hawkins CF : Qurt J Med, 1953; 26 : 481.

Cottrill C, Glueck CJ, Leuba V, Millett F et al : Familial homogenous hypobetalipoproteinemia. Metabolism, 1974; 23 : 779.

Crabbe PA, Heremans JF,: Selective IgA deficiency with steatorrhoea : a new syndrome. Am J Med, 1967; 42 : 319-26.

Crane CW, Newberger A : The digestion and absorption of protein by normal man. Biochem J, 1960; 74 : 313-23.

Curtis KJ, Sleisenger MH and Kimm VS : Protein digestion and absorption after massive small bowel resection. Dig Dis Sci, 1984; 29 : 834.

Dahlquist A : Assay of intestinal disaccharidase. Ana. Biochem, 1968; 22 : 99.

Dellovitz JA, Pape JW, Boney M, Johnson WD Jr : Clinical manifestations and therapy of isospora villi infection in patients with the acquired immunodeficiency syndrome. N Engl J Med, 1986; 315 : 87-90.

Deka NC, Sehgal AK and Chhallani PN : Absorption of fats and D-xylose in experimental giardiasis in rats. India J Med Res, 1982; 76 : 680-83.

Dimango EP, : Diagnosis of chronic pancreatitis: A noninvasive tests of exocrine pancreatic function sensitive and specific. Gastroenterology, 1982; 83 : 143.

Di Mango FPGOVIW and Summerskill WHJ : Relations between pancreatic enzyme output and malabsorption in severe pancreatic insufficiency. N Engl J Med, 1973; 288 : 813.

Domstad PA, Choy YC , Kim EE et al : Reliability of the dual isotope schilling test for the diagnosis of pancreatic anaemia or malabsorption syndrome. Am J Clin Path. 1981; 71 : 723-6.

Drummy GD, Banson JA, Jr and Jones LM : Microscopical examination of the stool for steatorrhoea. N Eng J Med, 1961; 264-84.

Duorkin B, Wormser GP, Rosenthol WS et al : Gastrointestinal manifestations of the acquired immunodeficiency syndrome. A review of 22 cases. Am J Gastroenterol 1985; 80 : 774-778.

Ehrenpris Elin D, Sam F, Guline Bruce K, Pattern SC et al : Kinetics of D-xylose absorption in patients with human immunodeficiency virus.Enteropathy Vol 49, No. 6, D-xylose malabsorption in HIV patients 633.

Edward J, Rich and Denmis L Christie : Antigliadin antibody panel and xylose absorption test in screening for celiac disease. J Pedaitr Gastroenterol Nutr, 1990; 10 : 2.

Falkenbach A, Klauke S, Unkelbach V, Marz W et al : Disorder of lipid metabolism in AIDS presented at the 5th International Conference of AIDS. Montreal, 1989; p. 266 (Abstract MBP 270).

Farthing MJG, Kensch GT, and Cassey MC :Effects of bile and bile salts on growth and membrane lipid uptake by Giardia lamblia. J Clin Invest, 1985; 76 : 1727.

Fariver S, Framm H, Hofmann AF : Breath test for altered bile acid metabolism. Lancet, 1971; ii : 621-5.

Finlay JM, Hogarth J and Nightman KJR : A clinical evaluation of the D-xylose tolerance test. Ann Intern Med, 1964; 61 : 411.

Fowler D, Cooke WT : Diagnostic significance of D-xylose excretion test. Gut 1960; 1 : 67-70.

French JM, Whitby JL, Whitefield AGW : Steatorrhoea in a man infected with coccidiosis . Gastroenterology, 1964; 47 : 642-648.

Friburghaus AU, Schmitz J, Schindler M et al : B-protein patterns of brush border fragments in congenital lactose malabsorption and in specific hypolactasia in the adult. N J Med 294; 1030; 1976.

Friedman AL, McEwen G; Small bowel absorption in portal cirrhosis with ascites. Am J Gastroenterol, 1963; 39 : 114-122.

Friedman SL, Wright, TL and Altman DF : Gastrointestinal kaposis sarcoma in patients with accquired immmuno-deficiency syndrome - Endoscopic and autopsy. Findings gastroenterology, 1985; 89 : 102.

Frowm H, Hoffman AF, : Breath test for altered bile acids metabolism. Lancet, 1971; ii : 621-5.

Gaskin KJ, Durie PR, Lee L, Hill R, Forstner GG : Colipase and lipase secretion in childhood onset. Pancreatic insufficiency. Delineation of patients with steatorrhoea. Secondary to relative calipase deficiency. Gastroenterology, 1984; 86 : 1-7.

Gaskin KJ, Durie PR, Hell RE et al : Calipase and maximally activated pancreatic lipase in normal subjects and patients with steatorrhoea. J Clin Invest, 1983; 427 : 34.

Gaskin KJ, Durie PR and Forstner GG : Calipase and lipase secretion in childhood onset pancreatic insufficiency Delineation of patients with steatorrhoea secondary to relative calipase deficiency. Gastroenterology, 1984; 80 : 1.

Geacey M : Intestinal absorption in the contaminated small bowel syndrome. Gut, 1971; 12 : 403-10.

Ghosh SK, Littlewood JM, Goddard D and Steel AG : Stool microscopy in screening for steatorrhoea. J Clin Pathol 1977; 30 : 749.

Giannella RA, Broitman SA and Zamcheck N : Competition between bacteria and intrinsic factor for vitamin B implications for vitamin B12 malabsorption in intestinal bacterial overgrowth. Gastroenterology, 1972; 62 : 255.

Gillin JS, Shike M, Alcock N Urmacher C et al : Malabsorption and mucosal abnormalities of the small intestine in the acquired immunodeficiency syndrome. Ann Intern Med, 1983; 102 : 619.

Gillin JS, Urmacher C West R and Shike M : Disseminated mycobacterium avium intracellular infection in Acquired immunodeficiency syndrome. Mimicking Whipple's disease. Gastroenterology, 1983; 85 : 1187.

Goff JS, Two stage triolein breath test differentiates pancreatic insufficiency from other causes of malabsorption. Gastroenterology 1982; 83 : 44.

Goldstein F, Karacadag S, Wirts CW, Kowlessar OD : Intraluminal small intestinal utilization of D-xylose absorption by bacteria : A limitation of the D-xylose absorption test. Gastroenterology, 1970;59:380-6.

Goodhart JM, Kingston GR : Modification of method for estimation of xylose in urine. J Clin Pathol, 1968; 22 : 621-2.

Goltrieda EB, Korsten MA and Liber CS : Gastritis and duodenitis induced by alcohol : An endoscopic and histologic assessment. Gastroenterology, 1976; 70 : 890.

Gray GM, Townley RRW and Couklin KA : Sucrose isomaltose deficiency absence of an inactive enzyme variant. N Engl Med 1976; 274; 750.

Green PHR : Alcohol nutrition and malabsorption. Clin Gastroenterology, 1983; 12 : 563.

Gupta BN, Narru KL Dhar : Evaluation of surface area collected peak blood xylose as a screening test of intestinal malabsorption in the tropics. Indian J Gastroenterol, 1987; 6(2) : 89-91.

Gwavava NJ, Pinkerton CR, Glasgow JF, Sloan JM et al : Small bowel enterocyte abnormalities caused by methotrexate statement in acute lymphoblastic leukaemia of childhood. J Clin Pathol 1981; 34 : 790.

Haeney MB, Guleef LS, Montgomery RD and Sammons HG : Evaluation of xylose absorption as measured in blood and urine of one hour blood xylose screening test in malabsorption. Gastroenterology, 1978; 75 : 393.

HolmesGKT, Hill PG, Dowe Still need to measure fecal fat (editorial). Br. Med J 1988; 296 : 1852.

Hamilton JD, Dyer NH, Dawson AM et al : Assessment and significance of bacterial overgrowth in the small bowel. Q.J. Med, 1970; 154 (Hawkin KI Pediatric xylose absorption test : measurement in blood preferable in measurement in urine . Clin Chem, 1970; 16 : 749-752.

Hamilton I, Worsley BW Cobden I, Cooke EM et al : Simultaneous culture saliva and jejunal aspirate in the investigation and small bacterial over growth. Gut 1982; 23 : 847.

Henson RK and Heenker TB : Tuberculosis peritonitis CT appearance. Am J Roentgenol 1985; 144 : 931.

Hawkins CF : The investigation of malabsorption. J Clin Path 1971; 5 : 151-7(Suppl.)24 (Roy Coll Path).

Hickey MS, Weavos KG : Nutritional management of patients with ARC or AIDS. Gastroenterol Clin North Amer, 1988; 17 : 545-561.

Higrechi S, Futershi G, Baba T, Sasaft D and Y : New method of testing for carbohydrate absorption. Dig Dis, 1986; 31 : 369.

Hill PG, Ross IN, Jacob F, Jyotheeswaran S, Mathan VI : One hour serum xylose as an absorption test in the tropics. J Clin Pathol, 1981; 34 : 174-8.

Hla Yee Y, Mya Tu M : The xylose tolerance test and renal function in the tropics South East Asian. J Trop. Med., Publ Health 1974; 5 : 593-7.

Hofmans AF and Polvej JR : Role of bile acid malabsorption in pathogenesis of diarrhoea and steatorrhoea in patients with ideal resection. Gastroenterology, 1972; 62 : 918.

Horkins LC, Winawer SJ, Broitman SA et al : Clinical giardiasis and intestinal malabsorption. Gastrointerology, 1967; 53 : 265-79.

Huang SS and Bagless TM : Milk intolerance in healthy orientals. Science, 1965; 160 : 83.

Hyams YS, Stalford RJ, Grand RJ and Watkins SB : Correlation of lactose breath hydrogen test intestinal morphology and lactose activity in young children. J Radiol, 1980; 97 : 609.

Isselbacher KJ, Scheig R, Plotkin GR and Caulfield JB : Congenital Beta lipoprotein deficiency : an inherited disorders involving a defect in the absorption and transport of lipids. Medicine, 1974; 43 : 347.

Jensen C, Buist NRM, Wilson T : Absorption of individual fatty acid from long chain or medium chain triglye ceride in very small infants. Am J Clin Nutr, 1986; 45 : 745-751.

Joshua M, Feibusch and Petter R Holt : Impaired absorptive capacity for carbohydrate in the aging human.

Jounela AJ, Pirttiaho H Palva IP : Drug induced malabsorption of vitamin B12 , VI malabsorption of vitamin B12 during treatment with phenformin. Acta Med Scand, 1974; 196 : 267-269.

Kaiharas, Wagner HN Jr : Measurement of intestinal fat absorption with carbon -14 labelled tracers. J Lab Clin Med, 1968; 71 : 400-11.

Kapemwa MS, Fleming SC, Griffin GF, Caun K et al : Fat absorption and exocrine pancreatic function in human immunodeficiency virus infection. Qu. J Med, New series 74. 1990; 273 : 45-56.

Kendal MJ : The influence of age on the xylose absorption test. Gut 1990; 10 : 498-501.

Kendall MJ, Nutter S, Hawkins CF : Xylose test effect of aspirin and indomethocin. Br Med. J, 1971; 1 : 533-6.

Kendall MJ and Nutter S : The influence of sex, body weight and renal function on the D-xylose test. Gut, 1970; 11 : 1020.

Kerlin P, Wong L, Harris B, and Capra S : Rice flour, breath hydrogen and malabsorption syndromes. A Pathophysiological approach. Gastroenterology, 1984; 87 : 578.

King CF, and Toskes PP : The use of breath tests in the study of malabsorption. Clin Gastroenterology, 1983; 12 : 591.

King CE, Toskes PP, Guilark TR, et al : Comparison of the one year $D^{14}C$ D xylose breath test to the ^{12}C bile acid breath test in patients with small intestine bacterial over growth. Dig Dis Sci, 1980; 25:53.

King CE and Toskes PP : Nutrient malabsroption in the Zollinger Ellison syndrome. Arch Intern Med, 1983; 143 : 349.

Kingham JG, Lerison DA and Fairclough PD : Diarrhoea and reversible enteropathy in Zollinger-Ellison Syndrome. Lancet, 2 : 610; 1981.

Kirschner BS, Defararo MV and Jensen W. Lactose malabsorption in children and adolescents with inflammation bowel disease. Gasteroenterology, 1981; 81 : 829.

Kolars JC, Levitt MD, Aoiji M and Savaino DA-Yogust - An autodigesting source of lactose. N Engl J Med, 1984; 310 : 1.

Kotter DP, Francisco A, Clayton F et al : Intestinal injury and parasitic diseases in AIDS. Ann Intern Med., 1990; 113 : 444-9.

Kotter PD, Goetz PH, Lange M, Klain EB, Holter PR : Enteropathy associated with the acquired immunodeficiency syndrome. Ann Interm Med, 1984; 101:421-8.

Kwaitt EL, Beeken WL : Limitations of the usefulness of the D-xylose absorption test. Am J Clin Pathol, 1975; 53 : 261-63.

Lanterburg BH, Newcamer AD, Hofman AF : Clinical value of the bile acid breath test. Mayo Clin Pio, 1978; 53 : 227-33.

Lantz B and N. Einhorn : Intestinal damage and malabsorption after treatment for cervical carcinoma. Acta Radiologica Oncology, 1984; 23 : 1.

Laughan BE, Druckman DA ; Vermen A et al : Prevalence of enteric pathogens in homosexual men with and without acquired immunodeficiency syndrome. Gastroenterology, 1988; 94 : 984-93.

Lebenthal E Lee PC : Development of hormonal response in human exocrine pancreas. Pediatrics, 1980; 66 : 556-60.

Lembike B, Krauss B and Lankische PG : Small intestinal function in chronic relapsing pancreatitis. Hepatogastroenterology, 1985; 32 : 145.

Leon-Barua R and Lumbrasas Curz H : The possible rate of intestinal bacterial flora in the genesis of diarrhoea and malabsorption associated with parasitosis. Gastroenterology, 1988; 55 : 559.

Levine JS, and Allen RH : Intrinsic factor within parietal cells of patients with juvenile pernicious anaemia. A retrospective immunohistochemical study. Gastroenterology, 195(55) : 1132.

Levitt MD, and Duane WC, : Flaoting stools - flatus versus fat. N Engl J Med, 1972; 286 : 973.

Levitt MD : Introduction and excretion of hydrogen gas in man. N engl J Med, 1969; 281 : 122.

Liebman WM : Xylose test in malabsorption. J Pediat, 1979; 93 : 508.

Linscheer WG : Malabsorption in cirrhosis. Am J Clin Nutr., 1970; 23 : 488-502.

Losowsky MS, Waiker BE : Liver disease and malabsorption. Gastroenterology, 1969; 56 : 589-600.

Logan RFA, Fifkind EA, Busuttil A, Gilmour HM, Forguson A : Prevalence and incidence of coeliac disease in Edinburgh and the lothian region of Scottland. Gastroenterology, 1986; 90 : 334-42.

Lundh G : The mechanism of postgastrectomy malabsorption. Gastroenterology, 1962; 42 : 637-640.

Mac Gregory IL, Moutin MS and Mayer JH : Gastric emptying of solid food in normal man and after subtotal gastrectomy and truncal vagotomy with pyloroplasty enterology. 1977; 72 : 618.

Main GA, Clark ML, Senior JR, : Distribution of D-xylose in sequentrated fluids resulting in false positive tests for malabsorption. Ann Intern Med, 1968; 69 : 1155-62.

Mawn MD, Hill ID, Peet GM, and Bowie MD : Protein and fat absorption in prolonged diarrhoea in infancy. Archives of Dis Childhood, 1982; 57 : 268-273.

Manousos O, Economidoub J, Papademetriouach, Triantaphyllidia J et al : Malabsorption associated with non malignant Immunoproliferative small intestinal disease. Digestion, 1987; 36 : 182-188.

Matuchansky C, Colin R, Hemet J et al : Cavitation of mesentric lymph nodes splenic atrophy and a flat small intestinal mucosa. Gastroenterology, 1984; 87 : 606.

Mc Corthy DM and Kim YS : Changes in sucrose enterokinases and peptide hydrolose after intestinal resection. The association of cellulose hyperplasia and adoptation. J Clin Invest 1973; 52 : 942.

Mc Evay A, Dutton J and James OF : Bacterial contamination of the small intestine is an important cause of occult malabsorption in the elderly. Br. Med J, 1983; 287 : 789.

Mc Evay A : Investigation of intestinal malabsorption in the elederly . In : Grimley Evans JG caird F eds. Advanced geriatric medicine, 2. London Pitman, 1982 : 91-99.

Mc Evay , Dutton J, James OFW : Bacterial contamination of the small intestine is an important cause of occult malabsorption in the elderly. Brit Med J, 1983; 287, 17 Sept.,

Meisel JL, Perera DR. Medigro C et al : Overwhelming watery diarrhoea associated with a cryptoporidium in an immunosuppressed patients. Gastroenterology, 1976; 70 : 1156-1160.

Merrick MV, Eastwood MA and Ford MJ : Is also acid malabsorption is underdiagnosed ? An evaluation of accurate diagnosis by measurement of serum HLA retention. Brit Med. J, 1985; 290 : 665.

Metz G, Gassual MA, Drason BS et al : Breath hydrogen test for small intestinal bacterial colonization. Lncet, 1976; i : 668.

Metz G, Gassall MA, Deosar BS et al : Breath hydrogen test for small intestinal bacterial colonization. Lancet, 1976; 1 : 668-9.

Miura Soichiro, Asakura Hitoshi, Munakata Yoshio, Kobayashi Kensuke et al : Lymphatic role in the pathogenesis of fat malabsorption in liver cirrhosis rats. Dig Dis Sci., 27(11) : 1982.

Mondhiry HA, Primary lymphomas of the small intestine. East west contrast. Am J Hematol, 1986; 22 : 89.

Montgomery RD, Halney MR, Ross IN, et al : The aging gut. A study of intestinal absorption in relation to nutrition in the elderly. Q J Med, 1978; 47 : 197-211.

Myluagancem K. Hudson PR, Ross A, Williams CP : ^{14}C-triolein breath test a routine test in the gastroenterology. clinic. Gut, 1986; 27 : 1347-1352.

Neale G, Gompertz D, Schonby H et al : The metabolic and nutritional consequences of bacterial over growth in the small intestine. Am J Clin Nutr, 1972; 28 : 1409-17.

New Comer AD, Hofman AF, Dimango EP, et al : A sensitive and specific test for fat malabsorption. Gastroetnerology, 1979; 76 : 6.

Newcomer AD, Mc Gill DE, Thomas PJ and Hofman AF : Prospective comparison of indrect methods for defecting lactose deficiency. N Engl J Med, 1975; 293 : 1232.

New Comer AP, Screening tests for carbohydrate malabsorption J Pediatr Gastroenterol and Nutr. (editorial).

Nieclerace C and Grendell . J Diagnosis of chronic pancreatitis, Gastroenterology, 1985; 88 : 1973.

Northfield TC, Dasar BS, Wright JT : Release of the small intestinal bile acid analysis in the diagnosis of stagnanth loop syndrome. Gut, 1973; 14 : 341-47.

Okamoto E, Muttort CR, Zucker CL, Heird WC : Use of medium chain triglyceride feeding the low birth weight infant. Am J Dis Child, 1982 : 136; 428-31.

Osmal KL, Zinn WJ, Wharton GK : Simplified test of fat absorption : comparison of serum turbidity, chylomicronaemia and total lipid volume.

Pearson HA, Label JS, Kocoshis SA et al : A new syndrome of sidroblastic anaemia with vacuolization of marrow precursors exocrine pancreatic dysfunction. Pediatr, 1979; 95 : 970.

Pederson L, Anifed T, Hess Thysen E : Rapid screening of increased bile acid deconjugation and bile acid. malabsorption by means of the glycine-1-(^{14}C) cholyglycine assay. Scand J Gastroenterol, 1973, 8 : 665-72.

Peledy O, Dasan M, Laufer, Benjamin Y and Gilat T : D-xylose absorption test urine or blood ? Dig Dis Sci , 1991; 36 (2) : 188-192.

Perez-Santiago E, and Tutterworth CE. Amer J Dig Dis, 1957; 2 : 225.

Perman JA, Madleir S, Barr RG and Rosenthal P : Fasting breath hydrogen concentration. Normal values and clinical application. Gastroenterology, 1989; 87 : 1358.

Pena AS and Truelone SC : Hypolactrasis and ulcerative colitis. Gastroenterology, 1973; 64 : 400.

Perlow W, Baraona E and Lieber; CS. Symptoms intestinal disaccharidase deficiency in alcoholics. Gastroenterology, 1977; 71 : 680.

Popovic OS, Kostic KM, Miloue VB, Milutinoik et al : Primary bile acid malabsorption. Gastroenterology, 1987; 92 : 1851.

Prince HL, Gazzaed BG, Dawson AM, Steatorrhoea in the elderly . Brit Med. J., 1977; 1582.

Prokipehuk EJ, Bayless TM, Iber JL and HendrixJR : Clin Res, 1961 : 9 : 331.

Radziuk J and Bandy DC : Abnormal oral glucose tolerance and glucose malabsorption after vagotomy and pyloroplasty Gastroenterology, 1982; 83 : 1017.

Race TF, Race K and Faloon WW : Intestinal malabsorption induced by oral calchicine, comparison with neomycin and cathartic agents . Am J Med Sci, 1970; 159 : 32.

Rambaud JC, Galian A, Touchord G, Morel Maroger L et al : Digestive tract and renal small vessel hyalinosis idiopathic nonatherosclerotic intracerebral calcification retinal ishcemic syndrome and phenotypic abnormalities. A new familial syndrome. Gastroenterology, 1983; 90 : 930.

Rao SSC, Edwards CA, Austin CJ, Bruce C , Read NW: Impaired colonic fermentation of carbohydrate after ampicillin Gastroenterology, 1988; 94 : 928-32.

Raptopoulos V, : Peritoneal mesothelioma CRC Crit Rev. Dign Fin. 1985; 24 : 293

Ras SA, Rose PE, Powell Jackson P, Berry H, Scott JT : Scleroderma chronic pancreatitis, malabsorption, clinicopathological conference. Presented to section of Rheumatology and Rehabilitation, 6 Nov., 1986.

Ravich WJ and Beyless TM : Carbohydrate absorption and malabsorption. Clin Gastroenterol, 1983;12:335.

Reber II - A. Chronic pancreatitis . In sle-isengner MH and Fordtram JS (eds) Gastrointestinal Disease, 2nd ed. Philadelphia WB Saunders, 1978; p. 1439.

Robert M Craig, Patrick Murphy, Thomas P et al : Kinetic of D-xylose absorption with chronic renal failure Vol 103 No. 3, D-xylose absorption in renal failure.

Robert M, Ingrom : The definitive "Gold Standard" test with which to establish the diagnosis of malabsorption in the quantitative determination of fecal fat in stool malabsorption. Post graduate Medicine, 1987; 81(7), May 13.

Robert IM, Poturich C Wald A : Fecal fat connection as screening test in pancreatic insufficiency. Dig Dis Sci, 1956; 31(10) : 1021-4.

Robinson PJ, Sly PD, Smith AL, Chitravanshi SB : High compared with standard dose lipase pancreatic supplement. Arch Dis Child, 1989; 64 : 143-45.

Robin F, Rybav BJ, Lindenbaum J, Gerson CD, Walker G and Lieber CS : Ultrastructural changes in the small intestine induced by ethanol. Gastroenterology, 1973; 63 : 81.

Robels EA, Mezey E, Halsted CH et al : Effect of ethanol on motility of the small intestine. Johns Hopkins J, 1974; 135 : 17.

Robinson PJ, Smith AL, Sly PD, Frac P; Duodenal pH in cystic fibrosis and its relationship to fat malabsorption. Digestive disease and Sciences Vol 35, No. 10(October) 1990; 1299-1309.

Rodgers VD and Kagnoff MF : Gastrointestinal manifestations. of acquired immunodeficiency syndrome. Western J Med, 1987; 146 : 57.

Rolles CJ, Kendall MJ, Nutter S, Anderson CM : One hour blood xylose screening test for the coeliac disease in infants and young children. Lancet, 1973; 2 : 1043-5.

Roy CC, Levy E, Green PHR, Suiderman A, Litarte J, Bals, J.P. orguin J et al : Malabsorption hypercholesterolemia and fat filledenterocytes. with increased intestinal apoprotein, chylomicron retention disease. Gasteroenterology, 1987;93:390.

Ryan MG and Olsen WA. A diagnostic approach to malabsorption syndrome : A pathophysiological approach. Clin Gastroenterol, 1983; 12 : 533.

Sammons HC, Morgan DB, Frazer AC et al : Modification in the xylose absorption test as an index of intestinal Line . Gut, 1967; 8 : 348-353.

Samtini R, Sheehy TW, Martinez de James : The xylose tolerance test with five gram dose . Gastroenterology, 1961; 40 : 772-74.

Schein R, and Gelb A : Isospera belli in a patients with accquired immunodeficiency syndrome. J Clin Gastroenerool, 1984; 6 : 525.

Schneider A, Novis B, Chen V and Leichtman G : Value of the 14C-D-xylose breath test in patients with intestinal bacteria overgrowth. Digestion, 1985; 32 : 867.

Sciaretta G, Giocobazzi G, Verri A, Zanirato P et al : hydrogen breath test quantification and clinical correlation of lactose malabsorption in adult irritatic bowel syndrome and ulcerative colitis. Dig Dis Sci, 1984; 12 : 109.

Sciaretta G, Vicini G, Fagioli G, Verri A et al : Use of 23 selena 25-homocholyltantitic to detect bile acid malabsorption in patients with ileal dysfunction or diarrhoea. Gastroenterology, 1986; 91 : 1.

Scolt BB, Jenkin D : Endoscopic small intestinal biopsy. Gastrointest Endosco 1981; 27 : 162-7.

Seigel RS, Kuhns LR, Berlaza GS, Mccosmick TL and Simmans JL Computed tomography and angiography in ileal carcinoid tumor and retractile mesenteritis. Radiology,1980; 134 : 437.

Shafer RB, Prentiss RA, and Bard J. II : Gastrointestinal transit in thyroid disease. Gastroenterology, 1984; 86 : 852.

Shammas MH, Ghazahtar SAS : D-xylose test in interic fever, cirrhosis and malabsorptive state. Med J, 1960; 1 : 836-838.

Sladen GE, Kumar PJ : Is the xylose test still a worthwhile investigation ? Br. Med J, 1973; ii:223-6.

Smith PD, Lane C, Gill VJ et al : Instestinal infection in patients with the acquired immunodeficiency syndrome (AIDS). Ann Intern Med, 1988; 108 : 328-33.

Sleisenger MH, Beaudborg LL : Malabsorption. Philadelphia WB Saunders Co., 1977.

Spiller RC, Higgins BE, Frost PG, and Silk DB: Inhibition of jejunal water and electrolyte absorption by therapeutic doses of clindamycin in man. Clin. Sci, 1984; 67 : 117.

Stear LE, Ek BO, Familial amyloidosis with polyneuropathy. Aspects of the relationship between gastrointestinal symptoms. E.M.G. findings and malabsorption studies. Scand J Gastroenterol, 1984; 19 : 480-86.

Stephen AM, Haddal AC and Phillips SF, Passage of carbohydrates into the colon. Direct measurements in humans. Gastroenterology, 1983; 85 : 589.

Stein RL, and Gruninger RP : AIDS with mycobacterium intracellulose lesions resembling those of whipple's disease. N Engl J Med, 1983; 309:1323.

Suarez C, Pereda JM, Morenol Martin, F. Garcia Gonzalez J. Gamez orbaneja. Prurigo nodulosis associated with malabsorption. Dermatologica, 1984; 169 : 211-214.

Theodosst A and Gazzard BC : have chemical tests a role in diagnosing malabsorption. Ann Clin Biochem, 1984; 25 : 153-165.

Theslett P, Benani C, Martenssonti, Nilsson A, Sundler F, Akesson B : A mixed endocrine adrenal tumour causing steatorrhoea. Gut, 1986; 28 : 1298-11361.

Thomas FB, Caldwell JH, and Greenberger NJ : Steatorrhoea in thyrotoxicosis. Relationship to hypermotility and excessive dietary fat. Ann Intern Med, 1973; 78 : 669.

Thorsgaard Pedersen N, and Halgreen H : Simultaneous assessment of fat maldigestion and fat malabsorption by a double isotope method using fecal radioactivity. Gastroenterology, 1985; 88 : 47.

Tillman RT, King CE, and Tosker PP : Continued experience with the xylose breath test. Evidence that the small bowel culture as the gold standard for bacterial overgrowth may be furnished. Gastroenterology, 1981; 80 : 1304.

Tokes PP : Bentiramide as a test of exocrine pancreatic function in adult patients with pancreatic exocrine insufficiency: Determination of appropriate dose and urinary collection interval. Gastroenterology 1983; 85 : 565.

Tomkin GH : Malabsorption of vitamin B_{12} in diabetic patients treated with phenforming a comparison with metformin. Med J, 1973; 3 : 673-675.

Toskes PP, King CE, Spivery JC and Lorenz B : Xylose catabolism in the experimental rat blind loop syndrome test. Gastroenterology, 1978;74:691.

Ullrich R, Zeitz M, Heize W, Lage M, Goffken G, Aiecken EO : Small intestinal structure and function in patients infected with human immunodeficiency virus (HIV) evidence for HIV. induced enteropathy. Ann Intern Med, 1989; 111 : 15-21.

Van de Kramers JH , Teu Bakkel Huiniak H, Weijers HA : Rapid method for determination of fat in feces. J Biocchem, 1949; 177 : 347-355.

Van Goidscuhoven GE, Henke WJ, Vacca JB, Knight WA : Pancreatic function in cirrhosis of the liver Am J Dig Dis, 1963; 8 : 160-173.

Verkade HJ, Van Assell WA, Vank RJ, Bijleveld CMA et al : Fat absorption in premature infants : the effect of lard and antibiotics. Eur J Pediatr, 1989; 149 : 126-129.

Walther B, Clementsson C, Vallgreen S, IHSE I and Akesson B : Fat malabsorption in patients before and after total. Gastrectomy studied by the trioleine breath test. a Carreras et al.

Waldman TA, Steinfeld JL, Dutoher TF, Davidson JD and Gordon RS Jt. Gastroenterology, 1961; 41 : 197.

Watkins JB, Jarvenpaa AL, Szezepanik Van Leeuwen P, Klein P. and Rassin DK : Birth weight infant effects of taurine, cholesterol and human milk on bile acid kinetics. Gastroenterology, 85 : 793-800.

Webster SGP, Wilkinan EM and Gowland EA : Comparison of fat absorption in young and old subjects. Age ageing, 1977; 6 : 113.

Weizman Zvi, David A, Springer and Peter R, During radiologic manifestation of malabsorption : A nonspecific finding . Pediatric, 1984; 74 : 4.

Weizman Z, Frostner GG, Gastkin J, Kopelman H, Wang S, and Duric PR : Bentiromide test for assessing pancreatic dysfunction usin analysis of para-amino benzoic acid in plasma and urine. Gastroenterology, 1985; 89 : 596.

Weiss RL and Styker JA : C-lactose breath tests during pelvic radiotherapy the effect of the amount of small bowel irradiated radiology, 1982; 142:507.

Weser E : The management of the patients after small bowel resection. Gastroenterology, 1976; 71:146.

West P, Levin G, Griffin GG, Maxwell JD : Comparison of simple screening tests for fat malabsorption. Brit Med J, 1981; 282 : 1501-4.

West PG, Levin GE, Griffin GE, [illegible] et al : Comparison of simple screening test for fat malabsorption. Brit Med J, 1981; 282 : 1501-4.

Winawer SJ and Zamecheck N : Pathophysiology of small intestinal resection in man. In Class GBJ (ed) Process in gastroenterology Vol 1 New York, Gruen Stratton, 1968; p. 334.

Wruble LD and Kalser MH : Diabetic steatorrhoea : A distinct entity. Am J Med, 1964; 37 : 118.

Yang YM, Ducos R, Rosenberg AJ, Catron PG, Levine JS et al: Cabalamin malabsorption in three siblings due to an abnormal intrinsic factor, that is markedly susceptible to acid and proteolysis . J. Clin Invest 1985; 76 : 2057.

Zarting EL : Interpretation of the xylose absorptions test mode simple finally ? J Lab Med, 1988; 112 : 531-532.

Zumwalt SA, Schmidt RM : Nutritional factors associated with AIDS presented at the 3th international conference of AIDS. Montreal June 1989; p. 479. (Abstract the BP 378).
